Read "Fluorine The Furious"

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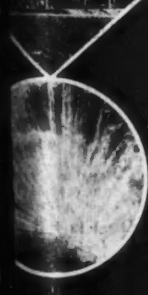

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Let's Get Back to Work

➤ TODAY the task before the whole world is to get up to date once more. For the past five years we have been living according to a pattern stemming straight out of the Stone Age. During the war we had phenomenal production. But it was aimed largely toward waste. Mankind's first impulse, given a new material, seems to be to throw it at somebody. Normal individuals outgrow this impulse at about six months of age, but nations conduct their affairs at this retarded level.

Scientists know better. They know how pitifully scant is the margin of safety which supports the human species on this little planet. They know the tremendous effort that goes into wresting the bare necessities of life from the indifferent earth. Occasionally they are able to glimpse some slight advantage which may help in this struggle, only to see it snatched out of their hands for tiny selfish advantage of this or that group, which only results in increased misery for all.

The patterns of war were set in a hunting culture. A little party of those young men who could best be spared went out to kill—an animal for food, if they were lucky—the other tribe who had interfered, if they were not. Weapons were the sole medium of human communication.

The world today is in a state of confusion through trying to adapt the much more friendly patterns it has learned through several thousand years of successful endeavor to the atavistic patterns into which we are always dragged back by war. We are suffering now a series of violent oscillations between these two patterns, civilization or its extinction.

The Stone Age had no need of scientists. Every physically fit young man could hurl a stone or wield a club. So, at the present day, the Army pays lip service to deferment of scientists, without whom our civilization cannot be carried on. But it continues to draft students whose training in civilian scientific research cannot safely be trifled with.

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—Photo courtesy Penn Salt Mfg. Co.

➤ BURNING WATER *is one of the strange effects when elemental fluorine is allowed to show its amazing chemical activity. Here fluorine, led in a tube from a storage cylinder to the surface of the water, breaks up some of the water molecules to form hydrogen fluoride, setting oxygen free. Energy liberated by this chemical reaction appears as flame.*

FLUORINE THE FURIOUS

by HELEN M. DAVIS

➤ WATER CATCHES FIRE, glass vanishes in a puff of smoke, and many other unusual things happen when the element fluorine, newly placed on the market, is let loose from the steel cylinders in which it is packaged. For this reason, its sale is at present restricted to experimental plants and laboratories where it will be handled by people who understand its dangerous ways.

Contrary to recent reports, fluorine is not explosive. It is merely active. Its

atoms hate to be alone. They rush so avidly to find chemical partners that they disrupt many materials we have been taught to look upon as safe. Compounds of silicon, among which are most kinds of glass and many minerals, are in this class.

Fluorine combines with silicon to form a gas. Therefore the rock or glass which looked so inert until fluorine came along will suddenly disappear, giving off energy, which may appear as flame. Even asbestos, type of fireproofing material, burns in fluorine, because it is a siliceous mineral fiber.

Since concrete is composed of cement, a mixture of calcium silicate and calcium aluminate, and sand, which is silicon dioxide, we may surmise that the Army had additional uses in mind in encouraging experiments in the production of fluorine on a large scale, beside the need in atomic bomb research for making uranium hexafluoride.

Most of the substances in the world are the result of combinations of the 96 or more elements. Only five or six elements are truly inert and non-combustible—the so-called rare gases, which together make up about 1/100th of the air we breathe, but have no effect other than to dilute the life-giving oxygen.

All the other elements enter into chemical combinations of some kind. The more active they are, the more readily they combine and the tighter they stick to those combinations. It takes energy to pry them apart.

Due to the structure of their atoms, the more active elements show greater energy of combination, and fluorine is one of the most active elements known. Under the right conditions, a more active element will always take a partner away from a less active one, the energy transfer appearing as heat given off or absorbed.

When a jet of elemental fluorine plays on the surface of a pan of water, the more active fluorine takes hydrogen away from the less active oxygen, and the water burns. The reason water does not usually burn, but instead may be used to put out fires, is because it does not usually meet an element more active than those which compose it.

Most of the combustion the fire department has to cope with is caused by carbon compounds combining with the oxygen of the air. For such fires, water, itself a compound of oxygen and hydrogen, is sufficient, for no element is present which wants either hydrogen or oxygen more than they want each other. The water is chemically inert, and puts out the fire by cooling the burning material and keeping elemental oxygen away from it.

Similarly, compounds of fluorine with other elements are apt to be stable, and many of them can be used to put out fires. Fluorine's energy was used up in their formation. The resulting compound is inert and satisfied.

With large quantities of fluorine at their disposal, due to new knowledge of how to separate and store it, chemists are experimenting with the properties and possible uses of many new fluorine compounds.

At the recent meeting of the American Chemical Society in Chicago, several sessions under the leadership of Dr. Earl T. McBee of Purdue Uni-

—Photo courtesy Penn Salt Mfg. Co

➤ "Fireproof" *takes on a different meaning when fluorine is around. Glass turns to gas (upper left), steel goes up in smoke (upper right), a splinter bursts into flame spontaneously (lower left) and even asbestos burns (lower right).*

versity were devoted to a symposium on fluorine. Chemists who have tamed the furious element told how they had first to find some material they could keep it in.

Tanks and pipes of carbon steel were found practical, they told the meeting. Carbon electrodes were used to lead the electric current into the solution from which the fluorine is to be extracted. Nickel electrodes were used for the poles where the corrosive gas is given off.

The employment of modern automatic gas-handling machinery using high pressures and low temperatures, sometimes as low as that of liquid nitrogen, made possible the production of this unfamiliar chemical. One of the subjects of research had to be methods for disposal of waste fluorine.

Although water will burn with fluorine, the process is tricky and not adapted to introducing fluorine into other compounds. University laboratories and industrial plants which have cooperated to find the best ways to make new fluorine compounds are enthusiastic about the use of cobalt fluoride, CoF_3, to make organic fluorine compounds. This method was reported to the Chemical Society by Dr. Robert D. Fowler of Johns Hopkins University and a group of associates.

Hydrocarbons in which all the hydrogen atoms have been replaced by fluorine atoms form one type of new chemical series whose properties promise to be revolutionary. As a generic name, they are called fluorocarbons, and individual compounds are called by the name of the corresponding hydro-carbon prefixed by the Greek letter *phi* (ϕ).

Now scientists foresee hundreds of uses for compounds of fluorine. Some outstanding ones are:

A non-inflammable, non-toxic liquid with a high enough boiling point and specific gravity that it can replace mercury in the present mercury vapor boiler, making the most efficient vapor engine practical and safe.

A gas, already developed but requiring elemental fluorine to manufacture, which is a nearly perfect insulator for high voltages used in x-ray and nuclear physics.

A lubricating oil so stable that it will not oxidize or break down under any present engine or mechanical operations and will make possible gears and engines heretofore only dreamed of by designers because no lubricant made could withstand their pressure and friction.

An insecticide, already made by the Germans but too costly to be practical with present methods.

Other uses for fluorine compounds now definitely within the realm of possibility include heat transfer and dielectric media, other insecticides, fungicides, fumigants, germicides, stable solvents, anesthetics, fire extinguishers and fireproofing materials, resins and plastics and weed killers.

The demands of total war jolted fluorine technology into its greatest evolution. The development of anhydrous hydrofluoric acid as a catalyst made possible the huge quantities of high octane aviation gasoline which did so much to give the Allies their air superiority.

Fluorine compounds are mentioned in the Henry D. Smyth report on the development of atomic energy by the Manhattan project.

Cryolite, the indispensable fluoride electrolyte in the manufacture of aluminum, was regraded as so essential to airplane manufacture during the war that special convoys were provided to assure its safe transport from the Greenland mines.

The biggest problem in their project, said researchers of the Whitemarsh laboratory of the Penn Salt Co., was packaging the gas after it was manufactured. The fact that steel and copper will resist fluorine corrosion very well at normal temperatures was a great help, but detailed research was necessary to develop gaskets to make the present containers leak-proof and safe.

A comparatively small amount of

—Photo courtesy The Johns Hopkins University.

▸ REACTORS *filled with cobalt fluoride are used to produce new organic compounds of fluorine with carbon, in researches reported by Robert D. Fowler, Professor of Chemistry at the Johns Hopkins University, and his associates. In the pilot plant shown here, the new compounds C_7F_{16} and C_8F_{16}, as well as fluorinated oils and other compounds were formed. Fluorinated organic compounds have added hundreds of new materials to the chemist's repertory.*

the gas is packed in each cylinder, at present one-half pound at 400 pounds pressure.

The gas is produced in an especially designed electrolytic cell containing potassium fluoride and hydrogen fluoride at about 100 degrees centigrade. The products of this electrolysis are hydrogen and fluorine. A special diaphragm extending into the electrolyte is necessary to prevent these two gases from combining explosively.

Another problem in manufacture is the complete elimination of water from the cell, since when it is present

the process gives off oxygen instead of fluorine.

It is believed that this factor, presence of water, caused the failure of the nearly successful attempt to isolate fluorine by Sir Humphrey Davy, great pioneer British chemist, in 1813.

The problem of isolating the element attracted the greatest scientific minds of the 19th century but baffled them. Several researchers are believed to have lost their lives or suffered great injury in the work.

Henri Moissan, French inorganic chemist, first produced fluorine by the electrolytic process on June 26, 1886. Sir Henry Roscoe, famous English chemist and statesman, hailed this as the solution of one of the most difficult problems in modern chemistry.

Properties and History of Fluorine

➤ FLUORINE is a nearly colorless gas about 30 percent heavier than air. It is ninth in the series of elements in the periodic table with an atomic weight of 19 and is the first element in Group 7, the halogens, which also include chlorine, bromine, iodine and element No. 85, which has not yet been discovered. Fluorine has only one valence, -1, whereas the other halogens are multiple valence elements. Its atomic structure consists of a nucleus having a positive atomic charge of 9, an inner shell of two negative electrons and an outer shell of seven negative electrons. This is an unstable atom and has a tendency to pick up the extra negative electron in the outer shell. One pound of the gas at room temperature would fill about 10 cubic feet.

The gas can be condensed below the critical temperature of -129°C to a liquid. Liquid fluorine boils at -187°C under pressure of one atmosphere. In physical properties fluorine resembles the fixed atmospheric gases, oxygen and nitrogen. It has an intense odor which some observers described as similar to ozone, somewhat chlorine-like and highly irritating. The toxicity of fluorine is said to be about the same as that of chlorine.

Fluorine reacts vigorously with most metals at elevated temperatures. It also reacts strongly with silicon-containing compounds; thus, it can support continued combustion of glass, asbestos, etc. In its reaction with hydrogen, fluorine gives off five and a half times as much heat as in chlorine's reaction with hydrogen.

Fluorine readily displaces chlorine and other halogens from the solid metal halides, such as sodium chloride or salt, and reacts immediately with water to form hydrogen fluoride, oxygen and some oxygen fluoride.

Fluorine can be handled at atmospheric or moderately elevated temperatures in metals; such as, iron, copper, magnesium, nickel and monel. In these materials an adherent fluoride film appears to give the necessary protection to the metal surface. Fluorine can be observed for brief times in glass or quartz vessels at atmospheric temperature if it is quite free from hydrogen fluoride.

Fluorine as it exists in nature must have been known to the ancients because, as one scientist classified it, it ranks 20th in abundance in elements

—Photo courtesy Penn Salt Mfg. Co.

▸ Barricaded *behind half-inch steel and bullet-proof glass, Dr. John F. Gall checks the loading of fluorine cylinders at the Whitemarsh Research Laboratory of the Pennsylvania Salt Mfg. Co., where the dangerous gas is produced for the market for experimental work. Although chemists have had a bowing acquaintance with fluorine for centuries, its quantity production has just been achieved. Some experimenters a century ago are believed to have lost their lives in attempting to isolate this formidable element. Under war-time impetus, methods have just been mastered for handling it with safety.*

found in the earth's crust. But it remained for George Agricola, the father of mineralogy to classify and name this amazing element in the year 1529.

He called the widely distributed fluoride minerals "fluores," which he derived from the Latin "fluo," meaning "I flow," when he recognized their ready fusibility and fluxing action.

The next step in fluorine's history

—Photo courtesy Houdry Process Corp.

➤ HYDROGEN-FLUORINE TORCH *with which the two gases, mixed and ignited at the tip, produce a temperature of over 6000°F., which welds copper, as well as nickel, monel metal and steel. Dr. Aristid V. Grosse of the Houdry Process Corp. demonstrates the torch, which he developed with Homer Priest of the Oak Ridge Laboratories, while working at the War Research Laboratories of Columbia University (now known as S.A.M.). Discoveries about fluorine and its compounds, which were made during the war, were the subject of a symposium at the American Chemical Society meeting.*

did not come until 1670 when Heinrich Schwanhardt, son of the famous Nuremburg glass cutter, George Schwanhardt, announced the amazing discovery that he could etch glass with the vapors given off by the mixture of fluores, by then known as fluorspar, and sulphuric acid.

In 1764, A. S. Marggroff distilled the same mixture in a glass retort and concluded that the sulphuric acid separated a volatile earth from the fluorspar. It is probable that the volatile earth he described was fluosilicate in specks precipitated by the attack on the glass.

C. W. Scheele, repeating these experiments soon thereafter in all metal apparatus, concluded that the sulfuric acid liberated a peculiar acid which he called fluor acid. Although early investigators tried to determine the true nature of this substance by decomposing it into its components, it resisted the efforts of such great chemical pioneers as Scheele and A. L. Lavoisier.

The pioneering in electrolytic chemistry and its use in the first isolation of elemental chlorine from hydrochloric acid by Sir Humphrey Davy early in the 19th century gave the first real clue to the existence of elemental fluorine. When Sir Humphrey published his work on elementary chlorine, Andre Ampere pointed out the analogy between hydrochloric and fluor acid. In two letters to Davy he suggested that electricity might decompose this acid into its elemental components.

He proposed that the resulting new element be called le fluor—fluorine—in agreement with the then recently adopted name of chlorine.

Ampere showed unusual foresight into the nature of the as yet undiscovered element when he wrote in this correspondence:

"The only difficulty to be feared is the combination of the fluorine set free with the conductor . . . Perhaps there is no metal with which it would not combine. But supposing fluorine should, like chlorine, be incapable of combining with carbon? This latter body might be a sufficiently good conductor for it to be used with success as such in this experiment."

No one could really doubt Ampere's prediction of the existence of this new element, but for more than 70 years it resisted every attempt to isolate it.

During this time many unsuccessful experiments were made to prepare the element. Davy seemed to be on the right track in his first attempts to follow Ampere's suggestions. In 1813 he attempted to electrolyze hydrofluoric acid. He used a cell made of horn silver (fused silver chloride) with platinum electrodes. He probably failed because of water in the liquid hydrofluoric acid.

Having failed in this, Davy attempted to drive fluorine from its compounds by means of chlorine in vessels of sulphur, carbon, gold, horn silver and platinum. But none appeared capable of resisting the action of the combinations.

Other investigators tried to decompose fluorine compounds with heat while some thought it was possible that fluorine might be obtained by a chemical process in which a higher fluoride would decompose into a

lower fluoride, giving off free fluorine.

But all attempts failed. Even the great Michael Faraday brought all his experience and keen imagination to the project and after many weary months wrote in 1834: "I have not obtained fluorine. My expectations, amounting to conviction, passed away one by one when subjected to rigorous examination."

So baffling was this problem, so elusive and difficult the element these pioneers sought, that they were driven back into dark-age thinking of alchemy. It was seriously proposed after Faraday's failure that fluorine was actually the universal solvent, the alkahest the ancients thought would make them gold.

Even so, the search continued. It is believed several lives were lost and undoubtedly numerous courageous researchers were injured.

Henri Moissan, a rather obscure French inorganic chemist, hit on the significance of the observation of Faraday and others that anhydrous hydrogen fluoride did not conduct an electric current. When water was present a current would pass but only the water would decompose, producing hydrogen and ozone.

But in 1885 he found that potassium fluoride could be dissolved in liquid hydrogen fluoride to produce a solution that would conduct current. One year later, on June 26, 1886, Moissan, by electrolyzing this solution at -23° in a platinum U tube and using platinum-iridium electrodes, decomposed hydrogen fluoride into hydrogen and fluorine.

For the first time the most chemically active element known to man was isolated.

Sir Henry Roscoe, famous English chemist, statesman, and educator, hailed this experiment as the solution of one of the most difficult problems of modern chemistry.

A very important step forward was made in 1900 when C. Poulenc and M. Meslous, French chemists, devised a metal fluorine cell of the diaphragm type. They found that copper could be used not only for the tank to hold the electrolyte devised by Moissan but also that copper would serve as a diaphragm to extend into the electrolyte between the two electrodes to keep separated the gaseous products, fluorine and hydrogen.

It appeared that this might not work because copper, a very good conductor, apparently would act as a bi-polar electrode in the diaphragm, liberating fluorine into the hydrogen side of the cell and vice versa. This probably would have caused explosions, or at least a very low cell efficiency.

However, they discovered that the copper quickly formed a fluoride film that insulated the diaphragm from the electrolyte and made a workable cell.

The first cell designed to work at elevated temperatures was reported by W. L. Argo and co-workers in 1919. They prepared fluorine by the electrolysis of molten potassium bifluoride at 225° to 250° centigrade in an electrically heated copper vessel which also served as the cathode, the anode being graphite. A copper diaphragm with slots was used to keep the two gases separate.

It is interesting to note that about this time the great commercial possibilities of fluorine chemicals were indicated by two discoveries.

The first hint of the value of these compounds as an insecticide came when an employee of the Natrona plant of the Pennsylvania Salt Manufacturing Company discovered in 1900 that powdered cryolite (sodium aluminum fluoride) effectively killed all the insects on his potato plants. This gave the world one of its most efficient garden and orchard insecticides and started Pennsalt into vast research on fluorine chemistry.

A German chemist about the same time produced a fluorine compound "as clear as glass and almost unbreakable," presaging the wonderful fluorine plastics now just being developed.

But the work to develop production of elemental fluorine by practical methods still went forward. A cell operating at 150° centigrade and with a nickel anode was used. A complete study of the effect of water on the electrolysis was made by Karl Fredenhagen and Oswald Krafft in Germany. They reported that water in the solution caused polarization and serious erosion of graphite anodes and contaminated fluorine gas with oxygen.

This work was all-important because although the research in fluorine organic compounds was being pressed during the last decade, it was definitely limited by the lack of sufficient quantities of the elemental gas and means of its control.

A great forward step was taken in 1931 when anhydrous hydrofluoric acid was first produced commercially by Pennsalt and the first tank car load of this powerful and dangerous acid was shipped by that company.

A great bulk of fluorine chemistry, such as the development of freons for refrigerants and production of high powered aviation gasoline, using this acid as a catalyst, grew out of this development.

A number of military projects instituted after 1941 required large amounts of the element's compounds and their active manufacture was pushed on a large scale. The production of hydrofluoric acid alone jumped from 5,000 tons in 1931 to an estimated 53,000 tons in 1944 and higher in 1945.

And now, with commercial production of the element itself underway, the wonders of fluorine chemistry sought so long are not far from realization.

On the Back Cover

➤ Etching glass *in the traditional manner, hydrofluoric acid announces its presence as a combustion product when fluorine burns in a cylinder of hydrogen. The photograph was taken by the Penn Salt Co., as were those at the beginning of the article, showing combustion in fluorine.*

Bomb Reporters Disappointed To Find Themselves Alive

Bomb Not "Just Another Firecracker"

➤ MANY OF THE reporters at Bikini did not expect to live, and hence assumed the atomic bomb was a dud when they survived the first blast, Walter J. Murphy, American Chemical Society editor who witnessed the tests said, at a luncheon meeting in Chicago.

The surprise felt by some writers at still being alive caused them to lose their objectivity and was one of the factors responsible for the false impression given to the American public that the bomb was "just another Fourth of July firecracker," declared Mr. Murphy, who said irreparable damage was caused by misleading initial reports on Operation Crossroads.

"When our ship was not destroyed, the press was greatly disappointed, but by the same token greatly relieved. I honestly believe a great many of the press representatives aboard did not expect to live."

Asserting that a large part of the public has lost its fear of the atomic bomb, despite vigorous effort by the press to counteract the effect of the first Bikini reports, Mr. Murphy said there were several reasons why so many original accounts were misleading.

"Many of the reporters failed to realize that the Navy was not attempting to simulate actual warfare, but was conducting scientific tests," he pointed out. "No enemy would limit himself to discharging one bomb.

"I am confident that even five or six bombs discharged over the target fleet at Bikini would have made the fleet entirely impotent."

When the first atomic bomb was detonated at Alamogordo, N.M., Mr. Murphy continued, those assigned to describe it were only six miles from the point of detonation, whereas reporters on the U.S.S. Appalachian at Bikini were 18 miles away.

Morever, he pointed out, the Alamogordo bomb was detonated about daybreak, while the first bomb at Bikini was discharged about 9 a.m. amid bright Pacific sunshine.

"The Alamogordo bomb was discharged at approximately 100 feet from the ground and in a desert area where a certain amount of minerals and ores are present," he continued. "Obviously the Alamogordo bomb was a much more colorful spectacle than one detonated several hundred feet over water at Bikini.

"There was little doubt that the bomb detonated at Bikini was somewhat less efficient that those detonated at Alamogordo, Hiroshima and Nagasaki. However, despite the alleged inefficiency of the bomb detonated on Able Day, the amount of destruction was sufficient to prove beyond any doubt that the atomic bomb is a revolutionary new weapon and the most dangerous one that man has yet devised. I am still very much a member of the League of Frightened Men."

World Atomic Energy Control Can Lead to Political Agreement

How Can Atomic Energy Be Controlled?

by David E. Lilienthal
Chairman, Tennessee Valley Authority

The following address, made to the general meeting of the American Chemical Society in Chicago, presents the views of the Board of Consultants on the international control of atomic energy and explains why they believe the plan they have worked out is the only feasible way out of an intolerable situation.

▸ Can atomic energy be so developed and so controlled that it will be used only for the advancement of human welfare and not be used for war and destruction? As we meet here tonight this is probably the world's number one question. Since June 14th a group of men meeting in New York City have been patiently seeking for an answer to this tough problem. This is the Atomic Energy Commission of the United Nations, made up of representatives of twelve countries, with Mr. Bernard Baruch the American delegate.

No answer to this question will be genuinely workable unless it is agreeable to every one of the Great Powers and all, or substantially all, the nations of the world. This is quite an order. In fact, *quite* an order. It may be something like insisting that a fellow who never in his life has broad-jumped more than ten feet must jump twenty feet. But if he feels he just *has* to jump twenty feet, if a deep chasm lies before him, and something pretty hungry is chasing him, the twenty feet is still one hell of a jump—but because he has no easy alternative, it's not impossible. Well, the world has no easy alternatives about atomic energy; none that I can see. If an answer can't be found, one that this country and Russia and the other nations find acceptable and workable, then we're bound to have a feverish arms race. This will not be just an atomic arms race (though atomic weapons will probably lead the list) but one clear across the board. If that happens, scientists and technical men will simply have to do what all the rest of us must then do, that is, change our whole way of living. And there won't be much peace of mind while we're making the change. Instead of devoting your skills as chemists to improving the lot of men, as you would prefer to do, you, like all the rest of us —if we get into this kind of arms race—will be working like mad to find ways of scattering our cities so as to defend ourselves, and spending our energies devising ways of destroying our potential enemies. Not a pretty prospect for science or industry, or civil liberties, or nerves, or anything else.

It was scientists and technical men —prominently among them chemists —who gave the world the large-scale release of atomic energy. This is the

supreme achievement to date of the scientific spirit and the scientific method. It is my own opinion that the only hope to control atomic energy and prevent its use for destruction lies in applying the scientific spirit and the scientific method to this problem. In a world thus far largely run by the ideas of politics and legalism, I freely admit that this would be something quite novel. But considering how unattractive are the alternatives, I don't believe that the twenty foot broad jump is out of the question, and I doubt if you do either.

The averting of war and the maintenance of peace are traditionally described as political problems, or as it is sometimes put, "These are matters calling for political decisions, reached and carried out by political methods." Typical political methods in domestic affairs as well as international relations are quite familiar to all of us. Their practitioners sometimes include business, labor and farm leaders, as well as politicians and statesmen—even, once in a while a scientist. And when a scientist goes in for political dogmatism, he can make a politician look scientific by comparison!

The political method, generally speaking, is based on the process of *first* deciding what answer you and your side wants, and *then* scurrying around for evidence and arguments and public opinion and force to support the answer you started with in the first place. Political methods—I am over-simplifying a bit, but not much—are based on three procedures, so far as the people are concerned, as follows:

First: Tell the people what you know they want to hear—regardless of the facts. This gives great scope for orators, slogan-makers, and dogmatists.

Second: Tell the people what *you* want them to hear—regardless of the facts. This is the technique of the well-poisoner.

Third: Tell 'em nothing, and make 'em like it. This is an ancient art, but its modern practitioners have brought it to a new high level.

Political methods are generally quite in contrast to the scientific spirit and method. In his Novum Organum, Francis Bacon said many, many years ago: "We cannot command Nature except by obeying her." The scientist, essentially a humble man, obeys Nature by honestly observing and then truthfully recording *not* what he *wants* to find, but what in truth he *does* find. The essence of the scientific method and spirit to me—a layman—is that it does not start with the answer, but with the facts, and draws its insight and its overtones from the facts.

It's not often that there is an opportunity to analyze what is called a political problem in a scientific spirit. But something of the sort did happen last winter. The product was an idea embodied in a document published by our State Department called "A Report on the International Control of Atomic Energy." The proposals of that Report for the Creation of a world-wide Atomic Development Authority have since been accepted by our President, Secretary Byrnes, and Mr. Baruch and his associates as basic to the American proposals presented by Mr. Baruch in an historic address

to the UN Atomic Commission to the world.

This Report represented the work and the unanimous agreement of a Board of Consultants of five men. We were men of widely differing backgrounds and experience. But all five of us had this in common—we had all had responsibility for technical enterprises, and therefore had grown accustomed to the methods of tackling problems that are characteristic not of politics but of technology. Chester Barnard, one of our associates, President of the New Jersey Bell Telephone Company, thinks scientifically about organization. Dr. Robert Oppenheimer, a physicist, was wartime director of the atom bomb plant at Los Alamos. Dr. Charles Thomas, a chemist and one of this Society's distinguished members, is director of Monsanto's research activities, and in charge of research at the atomic energy plant at Oak Ridge. Harry Winne is vice-president of General Electric in charge of engineering policy. Your speaker is Chairman of TVA. So that all of us had rather extensive and responsible experience in undertakings based on scientific and technical knowledge. This was indeed a strange team to be asked to try to find an answer to what is classified as a "political" problem.

We five locked ourselves up for two months, had the whole array of facts before us, and came up with a plan all of us believed was workable. That plan has been widely discussed and is fairly well known. We urged that the people of the world agree to entrust to a world agency, the Atomic Development Authority, the control and management of all activities concerning atomic energy that are dangerous—that is, dangerous to the security of the world—activities that are steps on the road toward the making of atomic bombs. These dangerous steps begin with the raw material: uranium and thorium. Under our proposed plan, factories to produce fissionable materials would all be owned and operated, not by rival nations, but by this world corporation functioning under world law and responsible to all the people.

But it is *how* our Board of Consultants went about trying to find a plan that is in some ways as important as the answer we came up with. For we didn't follow the typical political method of starting with the answer all neatly laid out, and then look around for facts and arguments to support our pet notion. We didn't start, for example, by asserting that the answer was world government and then pick out facts that would fit that answer. Nor did we say, "National sovereignty must in no wise be infringed," and then try to squeeze out a plan that would fit that dogma. No, we started somewhat as a chemist might, tackling a technical problem: with the facts as he found them.

You recall that a year ago when the world saw for the first time the fantastic destructiveness of the atomic bomb, many Americans said, "Now, this won't do; this must be the last time an atomic bomb is used. The people of the world must agree to outlaw the bomb." What was meant was that the nations would all sign a treaty that solemnly promised that none of them would ever in secret or otherwise make these bombs and use them in a war. All the nations would

devote themselves exclusively to the many wonderful peaceful uses of atomic energy — for electric power, for a war on cancer and other diseases, and research in a hundred fields.

My four associates and I placed the facts alongside this idea of eliminating the bomb by international agreement, and as a consequence we were forced to discard the idea. For those facts made it clear that there was no security whatever for people anywhere, no prospect of a moment's freedom from fear of an atomic armament race if this is all we had to offer—this outlawing by international covenant.

What facts? Well, fact No. 1 is this: the same materials and operations required to put atomic energy to peaceful purposes are adaptable, virtually without change, to the making of the stuff that goes into atomic bombs. This is true through almost the whole course of producing atomic energy.

In the light of the facts it was just political hoorah to talk about nations concentrating on peaceful purposes as if that called for entirely different processes and materials from those used for destruction. Once you have produced some of this dangerous material there are ways of doctoring or denaturing it, to make it rather safe, and not effective for bombs in that form; but you must *begin* with substances that, however useful for producing electric power or for research, can just as readily be used to destroy the cities of mankind. There's a fact —and a fact is a stubborn thing and no amount of political dogma can do anything to change a fact. (And there is another thing about a scientific fact: it pays no attention to national boundaries. There are no such things as American neutrons, say, and some different kind of Russian neutrons, and British neutrons. A neutron doesn't know about boundary lines.)

These being the facts, what does an international covenant never to use atomic bombs amount to? The nations would all go through the process of signing their names to a treaty, agreeing never to make atomic bombs, agreeing most that they will forbid their citizens to use fissionable materials except for peaceful purposes. But under the treaty each nation will be permitted to go on mining uranium and thorium and putting them through a plant that will produce materials that however valuable for peace are also readily suitable for a bomb.

Well, how much security—how much peace of mind would anyone get out of that? Mighty little. For as is well known the atomic bomb is a surprise weapon and a relatively cheap one. We are reliably advised that several hundred of these bombs used on a nation's cities would finish off any industrial nation of the world. The bomb was originally developed in secret and, assuming closed borders, could probably be developed by a nation in secret again. We concluded, unanimously, that if nations were rivals in the development of atomic energy materials that could be diverted rather simply from open, peaceful uses to secret, warlike purposes, an agreement by each nation to outlaw the bomb might even be worse than nothing at all. For it would create suspicion and fear as to what the other fellow is doing behind closed factory

doors and in hidden and secret laboratories and bomb plants; and fear and suspicion breed wars.

Then we said to ourselves: Suppose the world agreed to join together to crack down on anyone who violated the international agreement; who despite the agreement went ahead and made and used atomic bombs. We rejected that plan, too, for we could find precious little security in a plan to punish a nation *after* it had dropped hundreds of bombs and killed millions of human beings. As for such punishment as a deterrent, the fact is that there is a premium in atomic warfare in pulling the trigger first, so that your enemy won't be able to retaliate effectively. And there is therefore a great premium on making preparations secretly while your law-abiding and trusting neighbors are depending on international agreements that say on paper that the bomb will not be used. And with that kind of creepy atmosphere to live in, in time everyone would suspect everyone else, no one would have any sense of security, and everybody would be making atomic bombs in secret. The world would not be a very happy place.

But then this was suggested: Why couldn't we have an international inspection agency, to snoop into every factory and plant to see whether nations are fulfilling their agreement not to put fissionable material into bombs? Again we looked at the facts, explored them painstakingly, and the facts forced us to conclude that a plan of inspection as a sole safeguard was quite unworkable. One of those facts was simply this: If an international inspector is to provide security against secret evasions, that inspector must know at least as much about atomic energy as the people he's supposed to watch. And there's the rub. An inspector—a high grade policeman—simply wouldn't know enough to detect a skillful evasion. This is a new field, new developments as you well know are coming along, stepping on each other's heels. Because of new knowledge the plants that are built next year will almost certainly not be like the ones we have in the Tennessee Valley at Oak Ridge or at Hanford in Washington state; and if a nation wanted to mislead the world, it could design them quite differently, so they might look innocent to an inspector. In a race between a nation that has scientists trying to design new kinds of plants so the international inspector wouldn't recognize them, and an army of inspectors looking for the only kind of plants they know about, which are yesterday's plants, in that kind of race the inspectors probably wouldn't have much chance. The only people who would be genuinely qualified to protect the world against secret shenanigans would be those who know how to design and operate atomic energy plants—the chemists, the physicists, and the engineers. And that is one weighty reason we urged that world security be protected by a development and operating agency manned by just such technical people, acting not for rival nations, racing each other, but for all nations and all peoples.

Well, this is the way we took one set of facts after another and explored this problem, and the things we rejected as not workable furnished a clue as to what we thought would be workable. It was these objectives, and

this same method of analyzing the facts that led the President, and Mr. Baruch and his associates, to present the American proposal for such an Atomic Development Authority. There is a point in remembering that it was Woodrow Wilson who dubbed Mr. Baruch with the nickname "Dr. Facts."

The proposed Atomic Development Authority would not be a mere international detective force, but, as its proposed name implies, a development agency engaged in operations and extensive research. To provide security the ADA must *know*. Professor H. D. Smyth has said that the men on the Atomic Development Authority might well become the elite of the scientific world. "Able men," he continued, "devoted to the traditional ideals of science, and men eager to contribute to the increase and dissemination of knowledge regardless of national boundaries, will be glad to join this group." And this high caliber of talent would be essential to world security so that the agency entrusted with control would know as much as anyone in the world about new possibilities.

There is an even more important though perhaps less obvious reason why the agency should be more than a policing force. "To be genuinely effective for security," my associates and I stated in our Report, "the plan must be one that is not wholly negative, suppressive, and police-like . . . (It) must be one that will tend to develop the beneficial possibilities of atomic energy and encourage the growth of fundamental knowledge, stirring the constructive and imaginative impulses of men rather than merely concentrating on the defensive and negative. It should, in short, be a plan that looks to the promise of man's future well-being as well as to his security."

Some people have objected to our proposal because it doesn't guarantee an end to war. That's a valid criticism, for what we set out to do was to find a way to prevent the surprise use of atomic weapons. Everyone would be profoundly happy if someone would come up with a workable scheme that would eliminate all war with one stroke; but I don't anticipate that that's the way it will happen. That's the goal; it must be, of course; but to get to that goal we've got a long way to go and much to learn. Perhaps the best way to get there is to start with the most urgent problem, and that would seem to be atomic weapons. If we can't take this first step what chance is there for the full-blown world government some people believe is essential, or an end to all war? My own guess is, not much. But if in this one field of atomic energy the people of the world can develop a system of world law and a world operating and control agency, by following the facts and disregarding political dogma, then perhaps all of us can tackle the next worst problem in the same way, and get that behind us, and on to the next, and in this way begin to work together, begin to figure out our problems on the basis of facts, in something of the spirit that scientists go about their problems, and really look forward to a generation of great progress and security, of real development not only physically, but morally and spiritually.

Military Preparedness Advocated As Atomic Bomb Protection

The Atomic Bomb and Common Sense

by Bradley Dewey
President of the American Chemical Society

The viewpoint of those who believe military measures will avert hostile acts is presented in this address, which was given from the same platform as the foregoing one, at the American Chemical Society meeting.

▶ Five atomic bombs have now been exploded, two in the wrath of war. One was detonated under test conditions but in necessary haste. The last two bombs were exploded under superbly controlled conditions arranged to provide a maximum of usable scientific, technological and military data.

Reports—with a due regard for national security—have been made public upon each of these explosions. Brief factual summaries of the effects of the two bombs exploded last July at Bikini Atoll in the Pacific have been presented by two evaluation groups, one reporting to the President and the other to the Joint Chiefs of Staff.

Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, was the chairman of the Joint Chiefs of Staff Board and both he and I were members not only of this group but also of the Presidential Commission. The Joint Chiefs of Staff Board has not yet completed its over-all evaluation of the bomb bursts and hence it is necessary for me to emphasize, first, that the factual matter I will use today has all been published and, second, that any opinions or conclusions expressed are mine, are purely personal and do not necessarily represent the views of my associates on the board or of the American Chemical Society.

Before the Bikini tests the press and radio of the world deluged readers and listeners with sensational and grossly exaggerated tales of the destructive effects of nuclear fission. I am afraid that we cannot blame the reporters and announcers entirely for this false picture. They were aided and abetted by numerous scientists. Perhaps even conservative scientists contributed to this situation by failing to deny even obviously false and misleading speculations as to the magnitude of phenomena associated with the bomb. The bomb, to quote one writer, was "over press agented." It couldn't live up to what its advance agent had said about it.

Now, as a result, many of us fear that the pendulum of public interest has swung in the other direction and that the man on the street is underestimating atomic weapons just as he overestimated them after Hiroshima and Nagasaki and before Bikini.

The fate of our country, indeed of the whole world, may well depend upon a proper understanding of the destructive power of nuclear fission. It is my purpose here to try to put the atomic bomb in its proper frame of reference; to take it out of the realms of fantasy and into the field of hard-headed sense.

First of all: Is the atomic bomb just another weapon? Ever since my return from the Pacific I have been bombarded with this question: Is the atomic bomb just another weapon?

Unquestionably some of those who declare that it is just another weapon are cynics and, what is far worse, some of them have muscle-bound brains. A few civilians and soldiers have grown old in the practice of military concepts of bygone days and with age has come an inability to grasp something entirely outside their experience.

But, most of the people who are asking this question: Is the atomic bomb just another weapon, are honest, intelligent folk who have been misled in a way that is easy to understand and that is flattering but disconcerting to science and to men of science.

It is an old axiom of war that for every weapon there is a defense. Most of us are familiar with this axiom, so well exemplified in the race between armor piercing shells and armor plate and airplane bombing and anti-aircraft weapons.

There is also a newer axiom even better than the axiom of war though rarely formulated in words. It is the axiom that science always finds a way. Our generation has seen science lick so many problems which prior ages had been unable to solve that we have an almost superstitious faith in the ability of science to give us exactly what we want.

But there are certain "problems," if you can call them such, which science cannot solve and which scientists long ago abandoned and now refuse to discuss. The squaring of the circle is such a problem. Men once spent their lives at this vain task. Today everyone knows the circle cannot be squared, although only mathematicians know why. Perpetual motion is another such "problem." Today almost everyone knows we shall never have perpetual motion and bright high school boys know why.

You here in this room know—if you have given any thought to the matter—why there can never be a positive defense against a weapon of nuclear fission. There is, of course, the negative defense of distance and protection. We can run away from the bomb and we can burrow in the earth and we can erect massive shelters of concrete and steel. And of course there will be methods of evasion. Bomb-carrying planes can be shot out of the skies. The factories that make them can be destroyed. But I am sure that none of us relish relying on these negative defenses for our country.

Once started, no nuclear chain reaction can be stopped. Once an atomic weapon is detonated its multiple effects of death and destruction must be felt over an area of several square miles.

This time science cannot find a way. You scientists know this. We must make sure that every American

knows that an atomic detonation is all over in a few millionths of a second.

Science will not today, tomorrow or ever, find a strong, tough and light material which will shelter men, or munitions plants, or dock yards from the effects of the atomic bomb. Science, which in the last war, produced gas tight clothing and fabrics which would absorb deadly gases, cannot give us garments to protect us from radioactivity of the atomic bomb.

No, the atomic bomb is not "just another weapon," in the sense of the military axiom that for every weapon there is a counter-measure.

The atomic bomb has introduced into the pattern of war factors so new, so contrary to the thinking of the past and so vast in terms of death and destruction that it is no wonder that our minds are slow to grasp in its entirety the military implications of the dawn of the atomic age.

Let me try to tell you, out of my own observations at Bikini, something of these new factors with which the atomic bomb confronts us.

How does the bomb exert its power against men and their works?

Let me first discuss its effects against material and physical structures.

I will assume that most of you have seen the remarkable still and newsreel motion pictures of the bomb bursts at Operation Crossroads. No one who has seen these pictures can have failed to have been awed by the terrific power of the air blast. A battleship is probably the strongest work of man—a structure into which centuries of engineering practice have gone chiefly for the purpose of withstanding blast. In the last war cruisers, aircraft carriers and destroyers have shown that they "can take it." Yet this bomb blew down the superstructures of great ships and bent over staunchly built, bare, heavy steel masts like twigs before a gale. No warship within a radius of half a mile could have escaped major, crippling damage.

Why then, you will very properly ask, was the "box score" at Bikini so unimposing? Why were so few first line ships sunk, capsized or blown to bits? The simple truth is that these ships, although anchored far more closely together than any fleet since Pearl Harbor will ever be anchored, were still so deployed about the lagoon that only a few were in danger of destruction. I know this because the Joint Chiefs of Staff Board examined the mooring plans with the full knowledge that most ships would survive. It was necessary that these ships remain afloat. They were platforms upon which were mounted a variety of instruments whose recordings would give us otherwise unobtainable data about the bomb.

Both the Navy Department and the newspapers did their full duty in warning the public not to judge the bomb by the "box score." Yet I fear that such is human nature that these warnings largely went unheeded. Believe me now: The two bombs lived up fully to the expectations of the experts whose duty it was to predict their effects. If, as has been charged, the Bikini tests had been mere sabre rattling, designed only to frighten the

rest of the world with a show of atomic force, then by a mere alteration in the mooring plan the bombs would have sent a half dozen or a dozen ships of all classes to the bottom. Instead, the tests were carefully planned scientific experiments designed to preserve a maximum amount of evidence for later study.

You have heard it said and so have I that Hiroshima and Nagasaki were lightly built cities; cities of flimsy buildings which were, if I may use the phrase, "push-overs" for the atomic bomb, and that it would not be effective against our cities. This is a ridiculous statement. In the first place some of the buildings badly damaged in Nagasaki were of modern steel and concrete construction, built to withstand severe earthquakes.

But, neglecting this fact, one has only to look at the motion pictures of the Bikini blasts to visualize what would happen to one of our cities. Over an area of several square miles steel and concrete curtain walls would crack and bulge. Flying glass—the great menace in London during the dark days of the buzz-bombs—would slay and maim their hundreds. Secondary fires from broken gas mains, electrical short circuits, stoves, and furnaces—fires we would be powerless to quench with our water supply broken at a score of points—would rage through our homes, our warehouses, and our factories.

Now let us consider some of the unique lethal effects of the atomic bomb, effects not against works of stone and steel but against the human organism.

When the bomb bursts in air life is endangered over several square miles not only by the blast and heat waves but by radioactivity of several sorts.

At the instant of burst, neutrons, products of the fission, travel with almost the speed of light. For one fierce millionth of a second they speed death in every direction. Great thicknesses of steel, greater cross sections of water or of concrete offer protection against these lethal neutrons. But let me emphasize that truly great thicknesses are required. Where no massive barrier opposes them, neutrons must travel through thousands of yards of atmosphere before collisions with molecules of oxygen, nitrogen and of water vapor rob them of their deadly power.

The neutrons impart radioactivity to many elements and at Bikini it was demonstrated that as a killer there is great cause to fear radioactive sodium. Since sodium is a constituent of all body fluids, this neutron bombardment sets up radioactivity within the bodies of those exposed to it and ultimately, so to speak, they kill themselves by self-radiation.

The second principal lethal radiation is of gamma rays of millions of volts intensity. This super X-ray-like radiation is more easily protected against than is the case with neutrons. But this is of purely academic consideration. A man destined to die in hours, days, or weeks as the result of neutron action will not care if he has also been burned with gamma rays, hit by the shock wave, or seared by heat.

When a bomb is exploded under water the conditions are radically dif-

ferent from those when a bomb is exploded in the air. Here neutrons and the fission products are absorbed by the water, which is sprayed over an area of several square miles. If the water is salt water, the sodium in the water sprayed over the area is highly radioactive for several days, but by no means for as long a time as the fission products. The plight of personnel entrapped under such a shower of radioactive water is a sorry one unless thoroughly covered by a roof and provided with some method of fast escape from the contaminated area. About the only case where a man in this plight has any chance is when his sprayed ship is moving fast enough so that in the minutes in which he puts on his "Mae West" and jumps over the side, he finds his ship has moved into uncontaminated water.

Again, do these descriptions of the powers of the atomic bomb fit the description: "Is it just another weapon?" No! Once delivered there is no defense against it. It is devastating over an area of several square miles. It is a super weapon, the first super weapon.

All other explosive devices are tactical weapons, though of course it is true that strategies for their mass use have been employed. But the atomic bomb is essentially a strategic weapon. And we must not forget that our thinking should be in terms of not one bomb against a target but an overwhelming pattern of many bombs. Used with military skill against strategically important targets, it can rob an enemy of the power to wage war.

Frankly, I do not know anything about the cost of an atomic bomb, although I have been told that even now in relation to the damage it can do it is a cheap weapon. Nor do I know how many bombs any country can make per week, per month, or per year, or what number can be stockpiled. I do know, as you know, that it is only common sense to bear in mind that no country will start an atomic war without an adequate supply of bombs so that whole cities, sprawled out over hundreds of square miles, could be bombed out of existence by the use of a few bombs.

In short, the atomic bomb is a super-weapon of vital strategic importance for which the only defense is to keep the enemy from its use or to make him fearful of reprisals in kind. Its skillful use can bring victory in weeks where months, or years, have in the past been required. The fact that its devastation is limited to a few square miles only affects the few needed against a given enemy.

Now permit me to digress for a moment to discuss quite another question. Is the atomic weapon any more horrible than other weapons?

Modern war provides very few forms of pleasant death. For very simple reasons no nation used gas in the last war but they did use fire in many forms. There may be some element of personal choice in the matter of death but on the whole it seems to me that all deaths in war are horrible.

The atom bomb is a tiny David slaying its tens of thousands where the old fashioned block-buster Sauls slayed their thousands. London, shuddering in the dark under a constant rain of buzz-bombs, suffered long and

horribly. Would she have suffered any more had an atom bomb killed as many as all the V-2's, maimed as many, driven as many to the mad house? I do not pretend to know.

This is not a new question. With each new deadly weapon the question has been raised. To me it is a futile question. War is horrible and all its weapons are horrible—made to kill efficiently.

What does seem to me important—far from futile—is the fact that the atomic bomb will surely make any war shorter than those of the past.

Look at Germany today, loser in a long war. Look at her battered cities, her worn-out economy, her miserable, starving people on their impoverished fields. And look at England, victor in a long war—at her battered cities, her under-nourished women and children, her broken, worn-out factories.

Because the atomic bomb is a super-weapon it does not follow that we must hold that it means the extinction of civilization. It could mean shorter wars and wars less destructive to our civilization. The atomic bomb exists. We must face this fact squarely. And we must face the fact that it exists for evil or for great good—to make horrible war still more horrible or to put a final stop to war. To me this brings us to a simple reality—a nation sure of its own freedom from the temptation to wage aggressive war, which has a supply of atomic weapons and the means—airplanes, rockets or guided missiles—to deliver them, can rest assured that any other nation will hesitate to wage war against it with or without atomic bombs. It can very well be that such a nation can, by its mere possession of atomic weapons, insure the peace of the world.

I think I can find no better way of closing than to quote the last paragraph of the Joint Chiefs of Staff Evaluation Board's second preliminary report, which I might say in passing the powers that be in Washington saw fit to delete from the published version and which deletion I am now free to make known. I need hardly add that I heartily subscribe to the opinions expressed in the paragraph I now quote.

"National security dictates the adoption of a policy of instant readiness to defend ourselves vigorously against any threat of atomic weapon attack at any time and adherence to this policy until it is certain that there can never be an atomic war. One enduring principle of war has not been altered by the advent of the atomic weapon. Offensive strength will remain the best defense. Therefore, so long as atomic bombs could conceivably be used against this country the Board urges the continued production of atomic material and research and development in all fields related to atomic warfare."

I personally place great importance on the words "which conceivably could be used against this country." To me these words highlight the real problems which face mankind—how to outlaw war and how to use the atomic bomb in the achievement of this necessary goal in human relationships.

Bright Future for Chemistry
If Young Scientists Are Spared

A.C.S. Secretary Looks Ahead

by ALDEN H. EMERY

Talk given by Mr. Emery from Chicago as the guest of Watson Davis on the Science Service "Adventures in Science" program, over the Columbia Broadcasting System, during the September meeting of the American Chemical Society.

▶ THE 110TH MEETNG of the American Chemical Society was one of the largest ever held. All told, some 8,000 chemists, chemical engineers and industrialists from all parts of the United States and a few from foreign countries attended. The registrants represented just part of the Society's more than 48,000 members. In five days of morning and afternoon sessions, 749 scientific papers were read and discussed. At times 15 or more sessions were in progress simultaneously.

Chemistry touches every phase of modern life. Results of new research were presented in fields that included nutrition, biology, petroleum, rubber, fertilizers, plastics, and sugar, among a long and varied list. Chemical science is growing continually, always expanding. This program was the largest we ever had, partly because chemists and chemical engineers now can report details of many of their outstanding contributions to victory in the war. A large number of these developments still were classified as top secrets only a short time ago.

Perhaps the best news is that many of these developments, accomplished under the spur of war necessity, are now at work for new and better things in peacetime.

One of the wartime accomplishments was a dramatic triumph over fluorine, a wild and often dangerously reactive element which for decades defied efforts to harness it to man's directed use.

When the war broke out, we were able to produce only a few pounds of fluorine a day. But the war industries needed tons of it. And tons were produced, by development of better methods to make pure fluorine by electrolysis and of special containers in which to store it.

Fluorine was necessary for the atomic bomb project. Now it promises to bring us a great new expansion in chemistry through man-made combinations with other chemicals. Better textiles, insecticides, plastics and paints are only a few of the new products foreseen. Another is a lubricating oil so stable that engines can be redesigned for automobiles which will operate more efficiently.

Another group of reports was devoted to radiation chemistry. Radioactive or tagged atoms are being put to work to find answers to problems of nutrition, of growth, of structure, of disease.

Still another symposium dealt with the contributions of organic chemistry to the war effort. These included chemical warfare problems, the development of insecticides to whip the insect enemy, the chemistry of ex-

plosives, and the chemistry of synthetic rubber, which put and kept the military forces and the civilian population on wheels when the natural rubber supply was cut off. Now synthetic rubber is available for many uses in civilian life.

Another of the chemical victories in this war was the huge production of the life-saving penicillins. There are different kinds of penicillins. Each penicillin differs in its ability to control different kinds of bacteria. The choice of mold and the medium or diet on which it grows determines what kinds of penicillins are made.

The new research shows how the amount of a type of penicillin which is wanted can be increased by adding certain chemicals to the medium or food. It was also found that these chemicals increased the total amount of penicillin produced by the mold. Thus more penicillin can be made, and the penicillin can be "custom-built," so to speak, to contain more of a particular type of penicillin most effective against a certain germ.

Another very interesting report demonstrated the way to a short-cut in the recovery of convalescents from disease or injury. It is a question of diet. The short-cut method was found in the treatment of the starved victims of German concentration camps and German prison camps. It is reported that the recovery of these starvation victims could be speeded up by a diet high in proteins. The sources of proteins used were powdered milk and eggs, and other materials from equally common sources, a simple and inexpensive diet that can be made to taste like egg nog or ice cream.

This high-protein diet brought the starvation cases to health much more quickly than had been thought possible before. And after wounds or operations, it is said that the high-protein diet reduced the recovery period by as much as one-third in many instances. In peacetime application, this will mean a shorter stay in the hospital, and a quicker return to health.

Many of the papers concerned the chemistry of proteins and of amino acids, the building blocks of which proteins are composed. These amino acids are now being made synthetically and from natural sources to help in nutrition. The body can make some of the amino acids but not others, and the body must receive these essential ones in food. Chemistry slowly is getting closer to determining the structure of proteins—advancing toward the goal of being able to make them synthetically. Some new progress in this respect also was presented to this week's meeting. Incidentally, another study showed that cheaper cuts of beef are just as good or better than the choicer cuts as a source of amino acids. They just aren't as tender.

Vitamins are under constant study, both to determine their content in various foods and how the body utilizes them. New reports also were made on the effects of vitamin deficiencies. In other vitamin work, the diet needs of laboratory animals such as rats were determined, for vitamins and other essential foodstuffs. The determination of their dietary needs is extremely useful in experiments seeking clues to such problems as tooth decay and virus diseases.

Wartime research brought us super aviation fuel which is now powering our peacetime planes, and super fuel for our peacetime automobiles. This meeting of the American Chemical Society was told of new motor oils that last longer and make starting easier. These oils thin on cooling and thicken on heating. Petroleum chemistry is supplying the raw materials for many other products, such as plastics, synthetic rubber, and explosives.

Other reports dealt with the rates of solution of soaps in water and the pathways for diffusion of water vapor through textiles, a method of testing the potency of pain-relieving drugs, and one for the determination of water in oysters as a means of assuring better-tasting oysters on your dinner table.

Another great branch of chemistry deals with fertilizers and soil fertility. Farmers are benefiting from chemical studies of phosphates for fertilizing, from studies of soil acidity, and the effect of magnesium on the growth of various plants including tobacco and citrus fruits. Chemistry also is actively and successfully concerned with finding new uses for farm products, and for farm and woodland wastes to make industrial products. New findings also were reported on animal nutrition.

Other papers told of advances toward better paints, varnishes, resins and plastics. Anti-fungus agents have been developed for varnish and lacquer films, along with moisture-resistant coatings for metals. However, in talking of these new developments, one must bear in mind that some of those to which reference has been made have not yet been translated into purchasable commodities; some will require further research.

We have merely lifted the curtain a little to let you see what the future may hold. Our chemical laboratories have been busy and will be busy for a long time to come. The chemical industry is continually expanding. And behind its progress lies thoughtful organization. To illustrate, some of the sessions concerned problems in teaching fundamental topics in chemistry. Another reviewed the question of the patent system as it applies to chemistry and new products. Still another took up the construction and design of research laboratories.

However, it is well to bear in mind that new laboratories and modern equipment by themselves are meaningless. Unless these expanded research facilities can be staffed with thoroughly competent and experienced men, no results will be forthcoming. If highly-trained young research and production chemists and chemical engineers are taken by Selective Service for police duty in occupied countries, it is a foregone conclusion that the research on peacetime applications of wartime developments will be seriously delayed. Furthermore, the plans of the Army and Navy to expand their research programs will be critically handicapped. The American public must realize, even if some Selectice Service officials do not, that indiscriminate drafting now of the young scientists who were deferred during the war, means fewer jobs for our returned veterans and a serious impediment to progress toward strengthening the technological defenses on which we must rely.

Dr. Icie Macy Hoobler
Gets Garvan Medal

Women's Activities at Chicago

➤ A COMPREHENSIVE nutrition program extending from before birth to maturity, to raise the general health level and promote national security, was urged by Dr. Icie Macy Hoobler, research director of the Children's Fund of Michigan and one of America's leading authorities on nutrition and child growth, in an address to several hundred women chemists participating in the American Chemical Society's 110th national meeting.

Asserting that strong, healthy citizens are essential to national safety in critical times, Dr. Hoobler said:

"Research has demonstrated that a mother's lack of proper food during pregnancy and while she is breast-feeding her infant may result in her child having inferior body structure.

"Thus, procurement of greater numbers of strong and invincible men and women in a population must encompass a program which extends from before birth to maturity."

Dr. Hoobler spoke of "The Romance of Research" at a women chemists' dinner held in Normandy House, prior to a general meeting of the Society in Medinah Temple at which she received the Francis P. Garvan Medal honoring women in chemistry.

Although the science of nutrition, stimulated by the needs of World War II, has made tremendous advances in recent years, Dr. Hoobler said, "the story of food in action is only in its initial stage of development."

Future progress toward the conquest of hidden hunger, she predicted will extend man's mastery over many of the ills which still beset him.

With all due regard to the importance of various branches of medicine, Dr. Hoobler continued, "there is no more potent force in the extension of life and of the effective portion of the life span than the practice of the newer principles of nutrition."

"Chemical and biological research has laid bare many secrets locked in the everyday foods we eat and has demonstrated that human beings may be warped in mind and body through the lack of the right kind of food," she declared. "Students of nutrition have witnessed the dramatic effects of food on the health and well-being of man as well as other animals. With deficient diets, symptoms of malnutrition occur within a few weeks. Dramatic recoveries may occur within a few days after the missing nutriment, or a food containing it, is added to the diet.

"Thus, disfiguring and fatal diseases such as scurvy, pellagra, rickets and others have been demonstrated beyond a shadow of a doubt to be due to the lack of food components needed only in minute quantities but without which the body cannot function properly.

"The most recent facts are evidence

that food is a major factor in growth and development, in resistance to disease, in stamina and vitality, and in the maintenance of mental and physical health."

One reason that there remains so much to be accomplished in the study of nutrition, according to Dr. Hoobler, is the fact that it has taken man so long to realize that his first need is food.

"Indeed," she said, "it is a tragic reflection on today's 'enlightened' people that it took a global war to make us conscious of the importance of our food supply in the conservation of human life."

Now that this lesson has finally been driven home by such revelations as the fact that nutritional deficiencies, directly or indirectly, disqualified for military service about one man in every seven, Dr. Hoobler declared, intensified efforts should be made to improve general health through the principles of good nutrition, with special emphasis on the needs of children.

"Children, the citizens of tomorrow, must be properly fed if they are to reach maturity as healthy, efficient and constructive men and women," she said. "Stronger and better bodies are necessary for a greater civilization. They are no less important for living a good life and enjoying in full measure the bounties of this earth."

Immediately following her address the meeting adjourned so that the ladies might attend the General Meeting in Medinah Temple, and see Dr. Hoobler receive the Garvan Medal from Bradley Dewey, President of the American Chemical Society. In his presentation speech Colonel Dewey said:

"We honor tonight an outstanding and distinguished chemist in the field of nutrition. Since 1924 she has published more than 200 scientific papers and books. She is a member of 18 scientific societies, and the first woman to be elected chairman of a division of the ACS, the first woman to be chairman of the Detroit Section of the ACS, and the first woman member of the Detroit Engineering Society. During the war she was a member of the Food and Nutrition Board and chairman of its Committee on Maternal and Child Feeding. As Director of the Research Laboratory of the Children's Fund of Michigan since 1931, she has developed one of the outstanding research programs of America. Her work has been characterized by thorough planning, skillful execution, critical interpretation of data, and accurate reporting. For the substantial and distinguished contributions which she has made to our understanding of the nutrition of growth, of mineral metabolism, and of the chemistry of the red blood cell, all of great importance to human welfare, and for the inspiration which others have derived from her stimulating leadership, it gives me great pleasure to present the Women's Award in Chemistry, the Garvan Medal, to Doctor Icie Macy Hoobler."

Program for Women

➤ Women, both chemists and wives, assembled in goodly numbers in Chicago and showed their appreciation of the program arranged under the chairmanship of Hoylande D. Young, research associate University of Chicago, for their entertainment by at-

tending most of the events scheduled. The three 2½-hour historical tours of Chicago, personally conducted by Otto Eisenschiml, were outstanding. All busses were filled to capacity, and those fortunate enough to make the trip acquired a knowledge of Chicago that would have been impossible on the regular sight-seeing busses.

A welcoming tea at the Gordon Club Monday afternoon at which all registered women were guests, was attended by 168. Tuesday a luncheon at the Museum of Science and Industry, followed by a tour through the Museum, attracted many of the historically minded. The luncheon and style show at Marshall Fields on Wednesday was so popular that the supply of 125 tickets was soon exhausted.

Iota Sigma Pi held its regular breakfast Thursday morning and approximately 60 women chemists turned out early to attend it. National officers presented brief reports, and from the discussion it was evident that a number of colleges are interested in forming new chapters. Then came a conducted tour of Abbott Laboratories, lunch at the First Methodist Church, Evanston, a conducted tour of the Technological Institute. A beautifully appointed tea rounded out a full day's and week's program.

Information desks and headquarters for both groups of women were maintained at the Palmer House throughout the convention.

Chemical Transforms Germ Type

➤ Discovery of the chemical that transforms pneumonia germs from one type to another and thus creates a new heredity for succeeding generations of pneumococci has brought the $1000 Eli Lilly and Company Award in bacteriology and immunology this year to 35-year-old Indian-born Dr. Maclyn McCarty of the Rockefeller Institute for Medical Research.

The award with accompanying medal was presented at the Detroit meeting of the Society of American Bacteriologists, which makes the award jointly with the American Association of Immunologists and the American Society for Experimental Pathology.

The chemical which accomplishes the pneumonia germ transformation is desoxyribo nucleic acid, a substance found in the nucleus of cells of man and other higher animals, Dr. McCarty reported.

If the waxy outer capsule from a Type I pneumonia germ is removed, nucleic acid from a Type II pneumonia germ can be used to form a new capsule for the Type I germ. In forming that new capsule, however, the germ becomes a Type II germ and all its descendants are Type II germs. Large amounts of the substance used to cause the transformation can be extracted from them.

With the loss of its capsule, the germ loses its ability to cause disease. When it acquires a new capsule, it regains this disease-causing power. Dr. McCarty has also discovered that an enzyme from beef pancrease, desoxyribo nuclease, will inactivate the nucleic acid that changes the type of pneumonia germs.

Chemical Abstracts Celebrates in Advance Completion of Fortieth Volume This Year

Forty Years of Chemical Literature

"HAPPY BIRTHDAY to you!"—with a procession of cakes, each bearing four candles, one for each decade, the abstracting staff of Chemical Abstracts wished each other many happy returns at their regular get-together luncheon during the meeting of the American Chemical Society at Chicago.

Presiding at the head table was the editor, Dr. E. J. Crane, who has been with the publication since 1911, and guided its activities since 1914. With him was his wife, Mrs. Helen G. Crane, who, as associate editor, has a great deal to do with getting out this semi-monthly index to the world's advances in chemistry.

Dr. Crane is the fourth editor of the abstract journal, which was founded in 1907 by the American Chemical Society with the late Dr. William A. Noyes of the University of Illinois as its first edtior. Upon his retirement in 1909 the editorship was assumed by Dr. Austin M. Patterson, who held it until 1914. Mr. John J. Miller then ran the publication for one year until he turned it over to the present staff. Both Dr. Patterson and Mr. Miller were present at the anniversary luncheon.

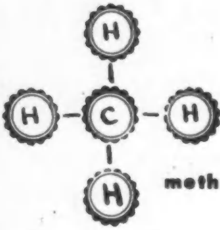
A featured guest was Dr. F. W. Zerban, the oldest abstactor in point of service, who has followed the literature on sugar chemistry for Chemical Abstracts since its first issue. For him the meeting was a gala occasion, as the sugar division was celebrating its 25th anniversary and the 60th birthday of Dr. Claude S. Hudson simultaneously.

The abstracting staff of Chemical Abstracts is made up of men and women in all parts of the country, who are assigned the publications they are to cover. Publications in foreign languages (thirty-one languages are encountered in this work) are abstracted in English. Russian journals are being followed with interest, and Dr. James Whitney Perry of M.I.T. is contributing to the *Journal of Chemical Education* from first-hand experience a series on "Chemical Russian, Self Taught."

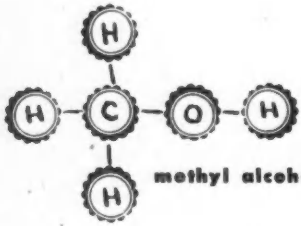
From a thin monthly issue in 1906, Chemical Abstracts has grown through its forty years to the bulky but compact journal which reaches present members of the American Chemical society every two weeks. One of the increasing problems of such a journal is indexing, and for Chemical Abstracts the scope of its cumulative index is of practically the same order of magnitude as the universal index to all knowledge which librarians are beginning to contemplate fearfully.

While canvassing the possibilities of speedier sorting to find a given subject, Chemical Abstracts continues to provide student and practical worker alike with one of the most consistently successful guides to information which have yet been devised.

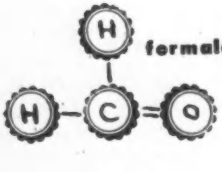
Hydrocarbon Oxidation Products



methane



methyl alcohol



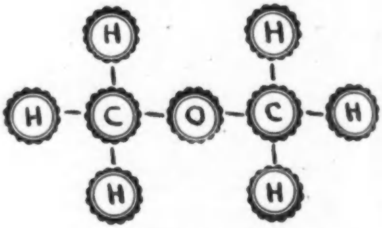
formaldehyde

formic acid

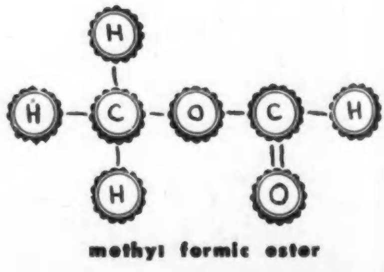
➤ AN ALCOHOL may be thought of as the hydroxide of a hydrocarbon radical. Further oxidation of an alcohol results in splitting off a molecule of water. This leaves attached to the hydrocarbon radical the group CHO, characteristic of an *aldehyde*. The name aldehyde itself comes from al [cohol] dehyd [rated].

Oxidation of an aldehyde causes the group to take on another oxygen atom to form COOH, the carboxyl group, the sign of an *organic acid*.

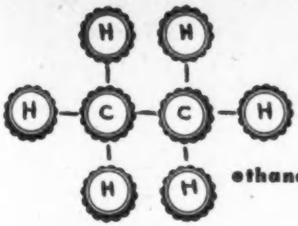
Organic acids can form compounds with metals, by replacement of hydro-



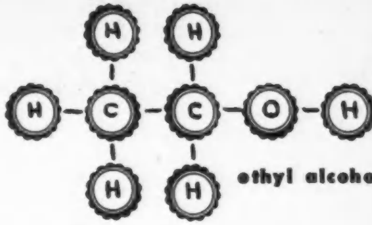
dimethyl ether



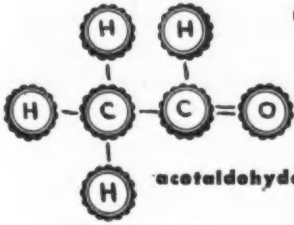
methyl formic ester



ethane

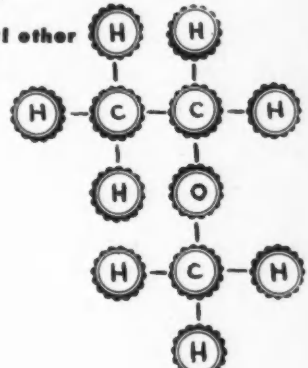


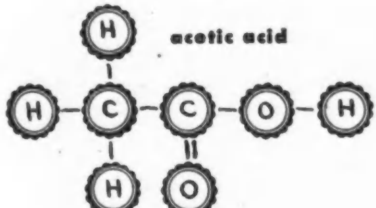
ethyl alcohol



acetaldehyde

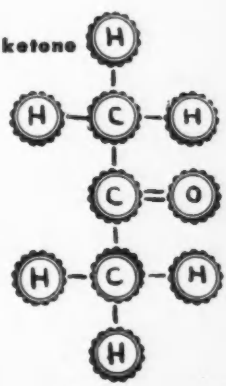
methyl ethyl ether



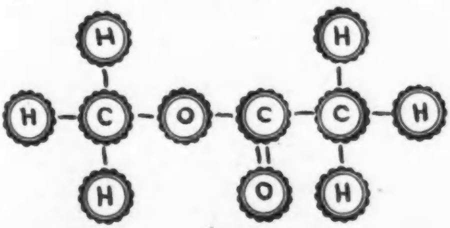


acetic acid

dimethyl ketone



ester: methyl acetate



gen. Simple compounds of this sort are thought of as *salts*. Potassium acetate, for example, has the formula CH_3COOK. More complicated organic groupings with metal replacements are spoken of as metallo-organic compounds.

Organic acids can combine with alcohols in much the same way that inorganic acids combine with bases, splitting off H_2O and joining the radicals that are left to form an *ester*.

Most organic radicals have a valence of one. Two such groups can join with an atom of oxygen to form an *ether*, the organic equivalent of an oxide. The radicals which the oxygen atom joins may be the same (as in dimethyl ether) or different (methyl ethyl ether).

In addition to being joined by an oxygen atom, to form an ether, two organic radicals may be joined by the group $=C=O$, which forms the *ketone*.

One of the most striking differences between organic and inorganic compounds is the small role played by ions among the carbon compounds. The student in the inorganic laboratory becomes accustomed to thinking of chemicals first according to their reaction to litmus paper—is it an acid or a base, or the solution of a neutral salt? Distinctions between organic forms are more subtle, and many reacting compounds are neutral to indicators.

Better Protection Against Silicosis

➤ Better protection of workers in certain industries from the hazard of silicosis appears likely as a result of a new method of sorting the dust in air developed by the Industrial Hygiene Foundation at Mellon Institute, Pittsburgh.

Silica particles so fine that more than 100 million can be piled on the head of a pin can now with the new method be sorted out of larger dust in factory air, Dr. Francis R. Holden of the Foundation, said in reporting the new development at the meeting of the American Industrial Hygiene Association.

The finer the silica dust, Dr. Holden continued, the greater the danger because only microscopic particles smaller than five microns are likely to damage the deep lungs. Particles larger than five microns, which is about the size of a red blood cell, are more readily trapped in the filter mechanism of the nose and throat.

Dr. Holden described the collecting, counting and analysis of dust in the dangerous size ranges as follows:

Visible and invisible dust in the workplace is determined by condensing dust floating in atmosphere equivalent in size to a small room, into a capsule-sized sample. This is done by drawing a measured volume of air through a powdery substance (salicylic acid). The substance is then dissolved in alcohol and the dust sample remains.

Through a process of sedimentation the total dust sample is divided into particle sizes above and below five microns.

For The Home-Lab

The Oxides of Nitrogen

by Burton L. Hawk

➤ To give expression to the private opinion of most chemistry students, the chief objection to the oxides of nitrogen is that there are too many of them. It is rather interesting to note that oxygen and nitrogen, which exist together in the elemental state under all atmospheric conditions, are capable of uniting with each other to form five different compounds. These compounds have somewhat unusual properties, and it will be worth our while to consider them in detail.

Nitrous Oxide, N_2O

➤ Better known as "laughing gas" or "sweet air," nitrous oxide is important as a local anesthetic—it is the "gas" the dentist uses during extraction of teeth. When inhaled it produces somewhat intoxicating effects similar to those produced by an overindulgence in alcoholic beverages—so we have been told.

In order to study the properties of the gas, set up an apparatus whereby you can collect several bottles of it over water—preferably warm water—similar to the method used to collect oxygen. Use a flask as your generator fitted with a two-hole stopper, thistle tube, and delivery tube. Cover the bottom of the flask with pieces of mossy zinc. Pour 10 ml. of con. nitric acid in 100 ml. of water and transfer the mixture to the flask. If the reaction is too slow, heat until a steady stream of gas is given off and you are able to collect several bottles of it.

One striking property of nitrous oxide is its ability to support combustion. Glowing splinters, steel wool, sulfur, etc. burn almost as brightly in nitrous oxide as in oxygen. You can demonstrate this property readily in the home laboratory.

Nitrous oxide can also be obtained by heating ammonium nitrate; however, this method is rather dangerous and we do not recommend it for the home chemist. Being of a temperamental nature, ammonium nitrate is not to be trusted. If heated too strongly or unevenly, it may explode violently.

In 1921 a terrific explosion completely demolished a chemical plant in Germany devoted to the manufacture of ammonium nitrate. The factory disappeared entirely, leaving an enormous crater in the earth over fifty feet deep—grim evidence of the explosive potentiality of this compound!

Nitric Oxide, NO

➤ Place a fresh quantity of zinc in your generator flask, and this time add to it a mixture of 5 ml. con. nitric acid and 20 ml. of water. The action will be more vigorous than before, and the flask will become filled with brown fumes. Wait until the brown fumes disappear, then collect a bottle or two of the gas, as before. Nitric oxide is colorless, but it readily reacts with oxygen to form the brown nitrogen dioxide, which explains why the brown fumes were observed at first in the flask. Remove the cover

from one of your bottles of colorless nitric oxide; it will turn brown. Here is an opportunity for you to create a few "magic" experiments to fool your friends. You can show them a bottle of colorless "air" which will be colored brown merely by removing the stopper—or by blowing in the bottle, etc.

One important reaction of nitric oxide is with ferrous sulfate. Allow the gas to bubble through a solution of ferrous sulfate for a few minutes and notice the color change. This reaction is the basis of the familiar "brown-ring" test for nitrates. The nitrate solution is mixed with ferrous sulfate solution and con. sulfuric acid is added. The sulfuric acid liberates nitric acid from the nitrate, and this in turn is reduced to nitric oxide: $6FeSO_4 + 3H_2SO_4 + 2HNO_3 \rightarrow 3Fe_2(SO_4)_3 + 2NO + 4H_2O$. The nitric oxide then forms the brown compound with ferrous sulfate ($FeNO \cdot SO_4$) which identifies the nitrate.

Nitrogen Dioxide, NO_2 or Tetroxide, N_2O_4

➤ We have already prepared nitrogen dioxide by allowing nitric oxide to react with air. To prepare in quantity, add 5 ml. of con. nitric acid to zinc in a large flask. The action is quite vigorous and large clouds of red-brown gas are given off. (Caution—posionous! Do not inhale!). Invert an empty flask above the generator to catch the gas. When filled with the brown fumes, stopper it.

Nitrogen dioxide is unique in that it changes color with the temperature. At low temperatures it is a yellow liquid; as the temperature rises it changes to a colorless gas, then pale yellow, light brown, and finally dark red-brown. The yellow liquid has the formula N_2O_4 and is a *polymer* of NO_2. At normal temperatures, both forms exist as a mixture.

You can observe the color changes of the gas by immersing the flask containing it in cold water. As the temperature drops, note the lighter color. By immersing the flask in warm water, the color darkens.

Nitrogen Trioxide, N_2O_3

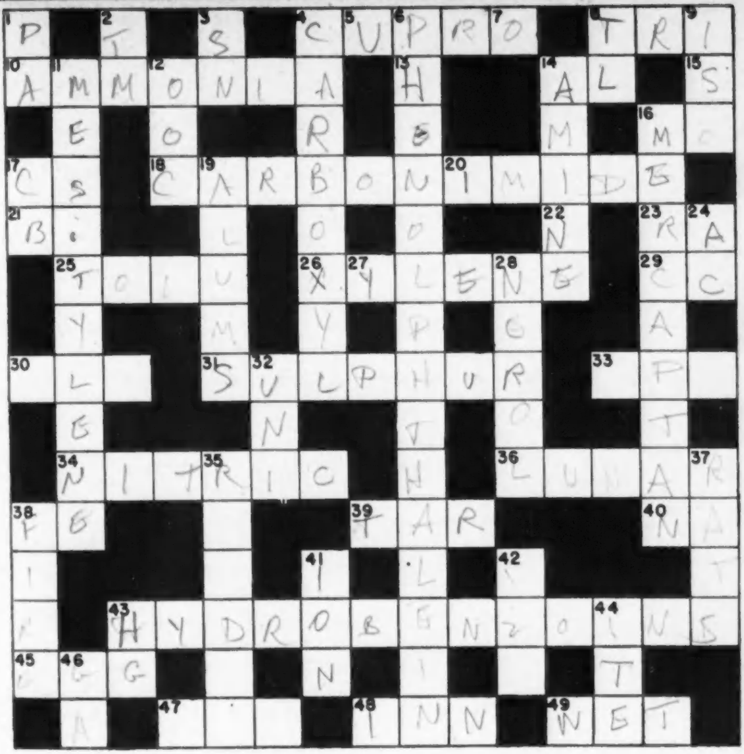
➤ Nitrogen trioxide is formed temporarily when sulfuric acid is added to a nitrite, but under normal conditions decomposes rapidly into a mixture of NO_2 and NO. Prepare a solution of sodium nitrite and add to it a small quantity of dilute sulfuric acid. Note the deep brown fumes of nitrogen dioxide.

If a mixture of the two gases, NO_2 and NO, is cooled to around 3 deg. C., a blue liquid is formed which is probably N_2O_3. There has been some doubt as to the existence of nitrogen trioxide. Whether the blue liquid formed is actually a true compound, N_2O_3, or a mixture of two gases, NO_2 and NO, has not been fully determined.

Nitrogen Pentoxide, N_2O_5

➤ The anhydride of nitric acid, N_2O_5, is a white crystalline solid. It is not important and is difficult to obtain in a pure state. It can be produced by dehydrating nitric acid with phosphorus pentoxide.

We hope these experiments have proven of value in acquainting you more intimately with the family of oxides of nitrogen—an interesting and versatile group to say the least!



All-Chemical Cross-Word Puzzle

Across

4. Combining form of a Group I metal
8. Prefix meaning three
10. Nitrogen compound
13. Hydrogen
14. Aluminum
15. Sulfur
16. Molybdenum
17. Cesium
18. Compound of carbon and nitrogen
21. Bismuth
22. Nitrogen
23. Radium
25. Famous balsam
26. Organic solvent
29. Volume measure
30. Prefix meaning sweet
31. Yellow element, old spelling
33. A source of salt
34. Inorganic acid
36. Kind of caustic
38. Iron
39. Source of organic compounds
40. Sodium
43. Hydroanisoins
45. Source of albumin
47. Water phase
48. Halogen suffix
49. Mode of analysis

Down

1. Protoactinium
2. Thulium
3. Tin
4. Organic radical
5. Uranium
6. Indicator
7. Oxygen
8. Thallium
9. Prefix meaning equal
11. Symmetrical trimethyl benzene
12. Suffix meaning of higher valence
14. Nitrogen and hydrogen
16. Smelly compound containing sulfur
17. Its other name is niobium
19. Certain crystalline sulfates
20. Iodine
24. Actinium
27. Yttrium
28. 3,7-dimethyl-2,6-octadien-1-ol
32. Prefix meaning one
35. Combining form of a rare metal
37. Laboratory animals
38. One form of energy
41. Charged atom
42. Types of dyes
43. Mercury
44. Of lower valence
46. Gallium

Answer on page No. Antimony

Chemical Progress in Relation To Many Other Fields Reported

Highlights of the A. C. S. Meeting

When chemists from all over the United States and elsewhere gathered in Chicago during the week of September 9-13, new developments were made known, not only in such strictly chemical matters as methods of analysis and details of plant design, but in ways that people with chemical training are aiding in improving the world's food supply, developing better medicines and antibiotics and producing new materials to do better jobs for specific purposes. Reports on some of the outstanding papers presented at the meeting follow, to give readers of CHEMISTRY *a survey of present trends in chemical progress.*

Atomic Energy Questions

➤ THE TWO PRIME questions that chemists asked at their national meeting were:

Can the destructiveness of the atomic bomb be put under effective control so as to prevent war?

Will atomic energy supply commercial power in competition with coal, oil and other fuels?

The two queries are very much related, because exactly the same processes are used in making power and making bomb material. Unless the problem of control of the bomb is licked on a world scale, it won't be safe to allow anyone to use uranium and thorium for generating power.

Among the chemists and other scientists, as among military men, politicians and others, there are those who go along with the idea that the best way to prevent atomic war in the world is for the U.S.A. to continue to make and stockpile atomic bombs and thus scare the rest of the world into not trying to make bombs and using them on us in an atomic Pearl Harbor. Col. Bradley Dewey, president of the American Chemical Society is a typical exponent of this view.

Others will uphold the official U.S.A. plan for a world atomic authority that will assume control over fissionable elements and see to it that they are used for good and not for destruction. Exponents of this view are TVA Chairman David E. Lilienthal and Dr. Charles A. Thomas of Monsanto Chemical Co., both among the five authors of the State Department report basic to present UN discussions.

The addresses of Dewey and of Lilienthal are reprinted in full elsewhere in this issue of CHEMISTRY.

Dr. Thomas is the authority whose figures were used in the report on the cost of nuclear power issued by the United Nations Atomic Energy Commission. This showed that a large power plant fueled with uranium would produce power almost as cheaply as a conventional coal power plant. Costs would be even lower if the cost of coal power continues an upward trend and the solving of technical problems in atomic power plants continues.

But the chemists who work on pe-

troleum and fuels from oil are not unduly worried about being out of jobs in the near future as a result of nuclear energy competition. Changes will come slowly and years will pass before oil and coal come into any real conflict with atomic energy.

At least two atomic energy power plants are being developed experimentally, one at Oak Ridge and the other at Hanford. Both of them will merely use the chain reaction pile for furnishing fuel to conventional steam boilers and the rest of a standard power plant.

Some extremely tough problems confront the designers. The chain reaction must be operated at high temperatures and just a little below the explosive fission point. There would be much greater chance of such a pile getting out of hand than the slower acting piles used to manufacture plutonium or produce radioactive isotopes for medical and industrial use. The disposal of radioactive fission products and the materials made radioactive by the pile, all highly poisonous, is another major problem.

These are chemical and engineering problems which scientists and engineers are confident they can solve. They seem simple, despite their complexity, beside the world task of uniting various nations and peoples in human and political control of atomic energy on an international scale.

Forecast of the Future

➤ When atomic power runs our great cities, sewage, garbage and other wastes will become valuable assets to the community, sterilized and cleaned by powerful superradiations so that new and useful products are produced and drinking water comes out of the sewers.

This was predicted by Dr. Milton Burton, now University of Notre Dame chemist, formerly head of radiation chemistry research in the atomic bomb development.

Cities of the future will run their sanitary waste disposal systems as parts of their atomic energy power plant. Troublesome products now difficult to dispose of will actually become the source of desirable new materials for medical and household use.

Homes, offices, factories and streets will be illuminated by cold light made possible by radioactive materials manufactured in the atomic energy piles, Dr. Burton predicted. The same kind of long-lived artificially radioactive isotopes as are now being distributed for medical use and investigation would be allowed to bombard chemicals that would produce intense light without much heat under such radiation attack. These are the same kind of phosphors that are used in the popular fluorescent lamps of today, but the future would see lamps without wires carrying electricity to them because their energy would come from the exploding of radiations from radioactive elements created in the atomic power plants.

New chemical processes for industry will result from the penetrating, high-energy radiation obtainable from atomic energy piles in large quanities and at high intensities.

Substances that usually can not be made to combine will join together to form strange and useful products,

Dr. Burton predicted, when they are brought under the influence of the powerful atomic radiations. Coal, natural gas and clays will be made to form new compounds of industrial importance, including new plastics never before made even in the laboratory.

New drugs, new vaccines, new radioactive dyes that will have curative properties for specific parts of the body are also foreseen.

New kinds of plants and animals, resulting from changes in the germ cells of new generations produced by the atomic energy radiations, are other possibilities.

Sugar Coating

➤ SUGAR COATING the dinner table to make it proof against spilled cocktails or marring from hot dishes is a possibility when new discoveries by Dr. E. Yanovsky of the U.S. Department of Agriculture Eastern Regional Research Laboratory, Philadelphia, are applied.

A film of the allyl ether form of many kinds of sugar, including the sucrose we put in our coffee, is put on wood, metal, cloth or other materials. Then it is changed into plastic right in place by heat and oxygen, so that a coating extremely resistant to solvents, oils and heat is formed. Starch from potatoes, corn, and tapioca can be used in much the same way. Glycerine and ethylene glycol, antifreeze chemical, can also be treated the same way to get sturdy plastic coatings.

What Do Redheads Have?

➤ HUMAN REDHEADS have something blonds and brunettes do not have. It is a matter of chemistry, demonstrated at the National Chemical Exposition held in connection with the American Chemical Society meeting.

It is a new organic compound of iron which can be isolated only from bright red human hair. Drs. Peter Flesch and Stephen Rothman of the University of Chicago Department of Medicine discovered that this chemical is one of the class of compounds that change color with difference in acidity, varying between bright rose pink and brown.

The redhead iron pigment cannot be used to make hair red, and it is now merely a chemical curiosity resulting from fundamental research on the chemistry of hair color.

Hot and Cold

➤ COLD AND HOT air from two branches of the same tube into which ordinary temperature air is blown was produced in a demonstration by Dr. H. A. Cranston of Chicago. In the future refrigerators and heaters will be parts of a new kind of machine using new principles of air flow, if this new apparatus based on German research can be applied on a larger scale. The trick of its operation is in the paths taken by the flowing air and the work done on the air by the shape of the tube.

Hearts in Unison

➤ THE HEARTS of atoms that make up molecules just cannot keep still. Pulsation in unison is the basis of the bond that binds chemical elements together to form the stuff of the universe. This may sound like a love story of the elements. It is a new theory of chemical bond presented to the American Chemical Society by a duPont chemist, Dr. Melvin A. Cook

of Gibbstown, N. J. He finds that what attracts and holds together elements can be explained by assuming that the nuclei or hearts of the atoms within the molecule cannot exist in stationary equilibrium but must execute periodic vibrations relative to each other.

Cows Need Cobalt

➤ A PREVIEW of what plenty of fissionable materials can do towards revolutionizing everyday life was provided by a paper presented at the meeting of the American Chemical Society by Dr. C. L. Comar and Dr. George K. Davis of the University of Florida. They demonstrated by means of "tagged" atoms of artificially radioactive cobalt that this element, needed in minute amounts to keep animals healthy, must be supplied to cattle constantly because they have no way of storing reserve supplies of it in their bodies.

The cobalt used in these experiments was made radioactive in a cyclotron, but larger supplies at much lower cost should soon be made available as the country's U235 and plutonium production facilities become available for turning out radioactive elements for scientific research purposes. Not only the relatively minor element cobalt but also such elements as phosphorus, calcium, potassium and sodium, all of major importance in animal and plant physiology, should soon be available cheaply and in quantity for use in experiments designed to answer old riddles in life processes, and to make the answers significant in increased food production and better health.

Distilling "Watery" Oysters

➤ A QUICKER, more accurate method for detecting the unhealthy condition of wateriness in oysters was described by Dr. H. N. Calderwood and Dr. L. W. Lane of the College of William and Mary. Usual method for estimating water content of any moist object is to weigh them, dry them to crispness in an oven, and weigh them again. Weight loss is assumed to be due entirely to water.

In the new technique of the Virginia chemists, the oysters are first given a chemical treatment, then boiled to drive off the water vapor, which is collected and condensed in a still, and then weighed. Besides being quicker, this method gives assurance that what the heat boils out of the oyster really is water.

Antivitamin May Be Medicine

➤ DOCTORS in the future may prescribe antivitamins as well as vitamins, it appears from a report by Morris Soodak and Dr. Leopold Cerecedo of Fordham University.

An antivitamin, as its name suggests, is a chemical that is antagonistic to a vitamin, competing with it for a place in one of the enzymes necessary to normal body functioning.

Oxythiamine, an antivitamin for thiamin or vitamin B_1, was reported by the Fordham scientists. Mice given oxythiamine starved to death for lack of thiamin but other mice were saved by large doses of the vitamin.

Successful competition by antivitamins sometimes starves disease germs as well as animals. This suggests the possible use of the antivitamins as remedies for some diseases.

The most rational approach to the discovery of new chemical remedies, the Fordham scientists pointed out, lies in further study of compounds like the antivitamins which are closely related in chemical structure to substances normally occurring in living organisms.

New Way to Give Vitamin A

➤ A SAVING of vitamin A, now in short supply throughout the world, may be accomplished as a result of the discovery of a new water solution for the vitamin. Benefit to children suffering from celiac disease and certain other ailments is also expected from the discovery, announced by Drs. Albert E. Sobel, Sidney P. Gottfried and Benjamin Kramer of the Jewish Hospital of Brooklyn.

Vitamin A is usually given in an oil. The new water solution, however, increases its absorption and utilization by the body. In normal children this increase may be as much as eight times, it appears from findings reported by the Brooklyn scientists.

Children with celiac disease and some other conditions go short on vitamin A, even when large amounts of the vitamin in oil are given because they fail to absorb it. When given in the water solution, this difficulty is overcome.

Since there is better absorption of the vitamin from the water solution, less of the precious material needs to be given with consequent saving in vitamin.

Plants Indicate Soil's Condition

➤ BOTANISTS can give chemists some useful pointers when it comes to finding out what's wrong with a given area of soil, Prof. Walter S. Eisenmenger of Massachusetts State College indicated. A man with a well-trained eye for plants can tell, by the presence or absence of certain species, a good deal about the chemical state of affairs down at root level.

In general, wild plants are more sensitive indicators of soil chemistry than cultivated plants, Prof. Eisenmenger stated, and he attributed this to the many changes man has wrought in the physiology of cultivated species during the long centuries since he first tamed them. Among the wild plants, the species farthest down on the ladder of evolution are the most responsive.

Speaking in particular about plant indicators of magnesium lack in the soil, Prof. Eisenmenger pointed out that grasses, which are highly evolved plants, can grow in soils so lacking in this element that more primitive groups, like the mallows and the clovers, cannot survive. He called his hearers' attention also to the fact that on lands newly reclaimed from the sea and not yet "normal" in their soil chemistry, grasses are often the only crops that can be grown for several years.

Magnesium Needed in Soil

➤ MAGNESIUM is not often thought of as an element that must be included in a complete fertilizer. Yet a real need for it exists in many soils of the United States, it was contended by Prof. Firman E. Bear, Dr. Arthur L. Prince, and Dr. Miryam Z. Kass of the New Jersey Agricultural Experiment Station.

Areas needing magnesium additions to the soil are primarily along the Atlantic and Gulf coasts. Potato-grow-

ing regions are also likely to be magnesium-deficient.

Protection in Radiochemistry

➤ THE ELABORATE PROTECTION that will be needed in chemical laboratories of the atomic age was described by Dr. Henri A. Levy of the Monsanto Chemical Company, working at the Clinton Laboratories at Oak Ridge, Tenn.

Three levels of radiation intensity must be dealt with, said Dr. Levy. The lightest, which he designated the submillicurie level, can be handled without any precautions beyond those of an ordinary laboratory. The intermediate, or submillicurie to millicurie level, will require some shielding around equipment, manipulation of certain vessels with long-handled tongs, and shielded vaults for storage.

Really dangerous conditions will exist at the final, or multicurie level. Here massive shielding of all equipment will be required, and all operations will have to be carried out by remote control. Special drains and storage facilities for radioactive wastes will be needed. There should also be an automatic alarm that will operate when radiation reaches a dangerous intensity.

Penicillin "Subassembly" Compounds

➤ PENICILLIN PRODUCTION by molds can be speeded in essentially the same way shipbuilding by men was speeded during the war—the sub-assembly method. Subassembly in shipbuilding meant bringing to the shipyard a whole bow, a whole stern, a whole cabin, already put together elsewhere and letting the workers weld them into place. Subassembly in penicillin production means putting into the molds' culture solution chemical compounds containing groups of atoms already arranged in patterns known to exist in penicillin.

Success with this method was reported before the meeting of the American Chemical Society by Dr. F. G. Jarvis and Dr. M. J. Johnson of the University of Wisconsin. They were able to increase the production of penicillin G by adding phenylacetic acid, which contains a ring of atoms characteristic of this particular penicillin variety. For a different penicillin, designated as X, the best subassembly molecure was that of para-hydroxy-phenylacetic acid.

Two other University of Wisconsin scientists, Dr. Kiyoshi Higuchi and Dr. W. H. Peterson, reported on a bacterial assay for the various kinds of penicillin. Three bacterial species respond differently to each of three different penicillins, so that their behavior in the presence of a mixture of penicillin "unknowns" gives an index to what is in it.

Lost Fertilizers in Lakes

➤ FERTILIZERS that we laboriously dump on our lands every year eventually wind up, in part, in the bottom waters of deep lakes into which the land drainage runs. Chemicals from industrial plants get "stored" there, too, Dr. C. N. Sawyer of the Massachusetts Institute of Technology told the meeting.

Analysis of water from three lakes in Wisconsin, he said, shows that for each square mile of bottom area they contain from 2,800 to 4,100 pounds of inorganic nitrogen, 1,035 to 1,180 pounds of organic nitrogen, and 35 to 62 pounds of inorganic phosphorus.

More Fertilizers Needed

➤ MORE FERTILIZERS will be needed for crops to be harvested in 1947 than were used even for the bumper crops of 1946 now being gathered into barns, said F. S. Lodge of the National Fertilizer Association.

The U. S. Department of Agriculture has set up as needs for the fiscal year 1946-47: 800,000 tons of nitrogen, 1,850,000 tons of phosphoric acid and 800,000 tons of potash. All these figures are substantially higher than the corresponding ones for the 1945-46 season.

It would be possible to meet all these needs, the speaker commented, except for the necessity for exports to meet government commitments to UNRRA, famine relief, and use in occupied territories. These may cause drafts on our reserve supplies, especially nitrogen, which will have to be replaced from the production of converted munitions plants which have been put into operation again.

Time is of the essence, Mr. Lodge insisted. It takes time to manufacture and mix fertilizers; a certain "curing" period is required before marketing; and days or weeks are consumed in transportation. In the meantime, the planting season does not wait.

Chemists in a Brown Study

➤ WHETHER A BROWN color suggests spoiled food and a dark-brown taste, or whether it is connected with such delectables as toast, roasted coffee, caramel and maple sugar, food chemists want to know more about it.

M. L. Anson of Continental Foods reported on studies by the Quarter-Master Corps' Committee on Food Research to determine why the G. I.'s objected to the looks of food stored at high temperatures in the Pacific Theater and what could be done about it. Sidney M. Cantor of Corn Products Refining Co. and Charles D. Hurd of Northwestern University have investigated the relationship between sugars and amino-acids in forming brown coloring materials.

Flavors dependent upon certain amino-acids have been detected by H. M. Barnes and C. W. Kaufman of General Foods Corp., who find that maple flavor results from alpha-amino butyric acid fused with glucose.

Europe's War Crops Were Good

➤ EUROPE'S FAMINE conditions might be far worse than they are, had not the war years on the Continent also been good crop years, Prof. Wendel H. Griffith of St. Louis University medical school told the meeting of the American Chemical Society. During the war, Prof. Griffith was chief of the nutrition branch of the Office of Chief Surgeon, E. T. O.

Although rationing and hard times prevailed in the cities, he added, the country people in Germany and German-occupied countries did not fare too badly. They simply kept enough of the food they produced to provide for their own needs before sending anything to the cities.

The Nazi policy of deliberate starvation of prisoners naturally worked hardships on prisoners of war, and even worse hardships on political prisoners. The malnutrition itself, however, carried with it a certain kind of protection: due to the slowed-down physiological processes of the emaciated prisoners, the effects of vitamin lacks were less pronounced than might have been expected.

This latter observation was confirmed in another paper presented at the same session by Dr. Herbert Pollack, New York City physician.

Amino Acids to the Fore

➤ Amino acids, the molecular "building-blocks" out of which proteins are constructed, are very much to the fore among the nutritional and food chemists. Increased realization of the importance of these compounds came as one result of wartime studies, and increasing ability to deal with them to best advantage in correcting human nutritional deficiencies was reported by several workers.

At the University of Illinois, young men volunteered as human guinea pigs in studies of the relative importances of the various amino acids. Of the 21 known compounds in this class, eight were found to be essential for the maintenance of human life. So long as one of the volunteers received his daily ration of all eight, plus necessary fats, carbohydrates and vitamins, he got along all right. But if one of the eight was omitted from his ration for any length of time, he began to show the effects.

Whereas it was formerly possible to obtain amino acids only by breaking up the protein molecules that contain them, some of them can now be manufactured synthetically on a practicable quantity basis, Dr. C. M. Suter and Dr. Sydney Archer of the Sterling-Winthrop Research Institute told their colleagues. Costs can be expected to go down as volume rises to meet increased demand.

Improved Niacin Production

➤ An improvement in the method by which niacin, or nicotinic acid, is made was announced by Dr. Donald F. Othmer and Dr. Sidney A. Savitt of the Polytechnic Institute of Brooklyn. This vitamin, now used at the rate of a million pounds a year for flour enrichment, is synthesized from a compound known as beta picoline. Dr. Savitt's contribution consists in a better and cheaper method of separating this from two chemically related but physiologically useless compounds, gamma picoline and 2,6 lutidine.

Crops Influenced by Soil

➤ "Tell me what you eat and I'll tell you what you are" has long been an accepted adage so far as human beings are concerned. Its extension into the world of the plants that feed us was suggested by Dr. L. A. Maynard of Cornell University.

We have long known that soils have influence on the plants that grow in them, he indicated; but really reliable data are lacking as to the specific influence of definite factors. Fragmentary knowledge, based on limited experiments or observations, sometimes lead to overenthusiastic claims and condemnations. What is acutely needed now, the speaker declared, is a series of well-planned research programs that will take in a wider complex of factors and try to give us a more complete picture.

Pectin From Sugar-Beets

➤ Pectin, familiar to housewives as the stuff that makes jelly jell, can be obtained abundantly and cheaply from sugar-beet pulp, Dr. Andrew Van Hook and Dr. Elizabeth Roboz of the University of Wyoming announced. At present, the chief use of beet pulp is as a stock feed, while pectin is obtained from other pulps,

such as apple pomace and cull citrus fruits, in which it exists at lower concentration.

In addition to its household use in insuring success in jelly-making, pectin is employed as an emulsifier in stabilizing oil-water mixtures such as salad dressings, and as a thickening agent in cosmetics.

Alcohol Production Tripled

➤ ETHYL ALCOHOL production was tripled during the war, largely to supply raw material for synthetic rubber, stated Dr. Walter C. Hess, of the Industrial College of the Armed Forces. This capacity is not likely to be needed for peacetime purposes, he added; though demand for industrial alcohol as a solvent, and as a raw material in many industries, will remain very great.

Other wartime chemical outputs that exceed present and immediate future demands mentioned by Dr. Hess were calcium carbide and plastics, both of which were more than double the anticipated needs of this country in 1950. One industry which may be able to work up to nearly full capacity is synthetic ammonia production. This was needed for munitions in the war, but is almost as urgently needed for fertilizer in a famine-threatened post-war world.

Edna and Dina: War-Twins

➤ Two WAR-BABIES with the deceptively feminine designations of EDNA and DINA were described by Dr. Ralph Connor of the Rohm and Hass Company. They are both explosives.

EDNA is short for ethylenedinitramine, a compound not quite as powerful as the already-disclosed super-high explosive RDX, but less touchy. Also, EDNA could be made out of ingredients not needed for RDX, which permitted simultaneous manufacture without competition for short supplies.

DINA is di-(2-nitroxyethyl)-nitramine, needed for suppressing the blinding flash of artillery powder in night firing. It was of particular value after the development of radar range-finding caused most naval gun battles to take place at night.

Yeast Helps Meat Shortage

➤ WHILE MEAT does another disappearing act, chemists told of new sources of proteins that can help bring it back—or, if cattle raisers and meat packers are obdurate in their sitdown strike, replace it altogether.

Yeast raised in enormous quantities, with sugar made out of wood as its principal food, is the key to the new protein supply, Dr. Robert S. Aries of the Northeastern Wood Utilization Council told his colleagues. Wood can be turned into sugar by an American improvement on a German process that was in use before the war.

The strains of yeast used in producing bread and beer do not make as efficient use of this sugar as a once "wild" species now known as Torula utilis. Accordingly, scientists tamed Torula and put it to work.

The dried yeast can be fed directly to cattle as a protein concentrate, or the protein can be extracted and refined for direct human consumption.

Alcohol from Wood Sugar

➤ THE SAME tamed yeast, Torula utilis, feeding on the same wood sugar, can also produce immense quantities of industrial alcohol—enough to meet

all the country's needs for this versatile fluid, declared Dr. Elwin E. Harris of the U. S. Forest Products Laboratory at Madison, Wis.

At the laboratory, this yeast has been "trained" to produce alcohol by continuous process instead of the batch method, Dr. Harris reported. Yeast cultures can be taken out of the end stage of the process, carried back to the beginning stage, and set to work all over again.

By this process, an average of 64.5 gallons of 95% alcohol was obtained from a ton of bark-free wood. Bark must be removed before processing, the speaker explained, because it contains phenols and other substances that inhibit the growth of the yeast.

Associated with Dr. Harris in this work were: Martha L. Hannan, Ralph R. Marquardt and Janet L. Bubl.

New Streptomycin Drug

➤ Discovery of a new kind of streptomycin which may prove more useful than streptomycin itself was announced by Harry M. Crooks, Jr., Mildred C. Rebstock, Quentin R. Bartz and John Controulis of Parke Davis and Company.

The new drug is a derivative of streptomycin called dihydrostreptomycin. It is as active against germs as streptomycin and in addition is much more stable. Its activity is not destroyed by a number of substances which do destroy streptomycin's anti-germ activity.

Whether the new drug will show the same advantages when used on patients as in laboratory tests against germs in test tubes is now being investigated.

Mice Shocked to Test Drugs

➤ A 15-volt electric shock on the tail is enough to make any mouse squeak. But, when fortified with aspirin or more potent morphine, mice at the Wellcome Research Laboratories, Tuckahoe, N. Y., bravely hold back their squeaks until the effects of the pain-relieving drug wear off.

By counting the number of shocks tolerated before a drugged mouse squeaks, Drs. John F. Reinhard and Edwin J. de Beer have accurately tested the strength of many common drugs, they reported.

Using morphine as a standard, the scientists have measured the potency of varying doses of alcohol, acetophenetidin, acetanilid, antipyrine, aminopyrine, aspirin, and Demerol by the new mouse-squeak test.

Giving Amino Acids

➤ Doctors may need to revise the dosage schedule for amino acids given to debilitated patients, it appears from findings reported by Drs. Elsa C. Proehl and Douglas V. Frost of the Abbott Laboratories.

Amino acids,. chemicals from which the body forms new protein tissue, have come into considerable vogue as treatment for undernourished and weak patients and in some cases for those recovering from surgical operations.

When they are injected above a certain level, regardless of the body's need for the nitrogen they supply, they will be excreted, the Abbot researchers reported. A kidney mechanism, they stated, controls the rate of excretion. The more rapid the injection rate, above a certain physiological level, the more rapid the excretion

and consequent wastage of amino acids will be.

Negroes' Skins Made Lighter

➤ NEGROES' SKINS were made several shades lighter by a cream containing ammoniated mercury, in experiments reported by D. F. Nealon of the National Toilet Company, Paris, Tenn. Results were given a definite recording by photographing the subjects, "before" and "after," against a background of known tone value.

Ammoniated mercury is a poison, but if the concentration in the cream is not too high and the treatment not kept up too long at a stretch there seem to be no ill effects.

The cream, of course, need not be a monopoly of the colored population. Caucasian brunettes aspiring to be blondes may try it if they like.

Acids from Pulp Mill Waste

➤ LACTIC ACID, which has considerable use in industry, food and medicine, can be produced cheaply from sulfate liquor, the pulp mill waste that is one of the nation's worst industrial headaches. A new fermentation process was described by Dr. Reid H. Leonard and Prof.. W. H. Peterson of the University of Wisconsin.

The crude liquor is first steam-treated to drive out sulfur dioxide, slightly alkalinized with lime and filtered to remove the sulfite precipitate. Then the fermenting organism, a special strain of Lactobacillus, is planted in it. Fermentation for 40 to 48 hours produces a little under 2% of lactic acid. The acid is taken out of the watery solution with an organic solvent such as amyl alcohol.

Acetic acid, another valuable industrial chemical, is also formed during the fermentation, and can be separated from the lactic acid by distillation. The yields per ton of pulp would be about 285 pounds of lactic acid and 75 pounds of acetic acid. While sulfite waste fermentation to lactic acid is technically possible, it will not solve the problem on the basis of the present market, the Wisconsin chemists pointed out. A mill with a 100-ton-per-day capacity could produce 9,000,000 pounds of the acid per year, which is far in excess of present sales.

Waste Potatoes Into Meat

➤ AT A TIME when we have plenty of potatoes but not enough meat, a proposal to turn unsalable potatoes into highly marketable beefsteaks by feeding them to cattle is bound to attract attention. This process was described by Alex C. Burr and A. M. Cooley of the North Dakota Research Foundation before an audience of agricultural and food chemists.

Cattle don't care much for fresh potatoes, so the two Dakotans worked out an economical process for drying them out. They put cull potatoes, which are ordinarily thrown out and left to rot, into a hammer mill where they are battered to a fine pulp. Then most of the water is removed in a rotary press, and the rest driven off by heat.

Cinnamon from Oat Hulls

➤ ANOTHER FORMER agricultural waste, oat hulls, is the ultimate source of an "ersatz" cinnamon flavor, described by Dr. Carl Bordenca of the Southern Research Institute at Birmingham, Ala. The substance is known chemically as furanacrolein, and is

prepared in two simple steps from the raw material.

Rubber Readied for Market

➤ Postwar production of natural rubber will be materially speeded up by a new method of coagulating the crude rubber and getting it out of the latex as tapped from the trees. The method was developed at the Malayan Research Laboratories of the B. F. Goodrich Company at Koala Lumpur, Selangor, F.M.S., by E. B. Newton and E. A. Willson of the company and W. D. Stewart of the Boyce Thompson Institute.

By the old process, the latex is acidified and allowed to stand over night. In the morning the rubber would be sufficiently well coagulated for handling. To meet the speed of the modern world, however, the coagulating process has been reduced to minutes instead of hours, by the adding of chemical accelerators. Certain phenols, fatty acids and alcohols have been found most suitable.

With the coagulation thus speeded up, the process of pressing the crude rubber into sheets can be made a continuous one, the three chemists reported. Latex, acid and accelerators are flowed together onto a conveyor belt, and by the time the mixture has reached the other end the rubber is already in the form of solid lumps, ready for forming into sheets.

Chemistry of Wood Rot

➤ When you put your foot through a rotted board in your porch floor, or sit down on a log in the woods, only to crash right through it, you are getting the benefit of the last stage in a long and complex chemical process; for fungi rot wood by oozing digestive enzymes on it—and enzymes are chemicals.

At the closing session of the American Chemical Society, Prof. F. F. Nord and James C. Vitucci of Fordham University told of their efforts to learn how molds chemically decompose wood.

The principal chemical attack seems to be made on the cellulose constituent; the other main part of wood, lignin, is apparently too tough for their digestions. The steps in fungal wood decomposition, as finally worked out, were first a breakdown of cellulose into glucose, then the fermentation of that into ethyl alcohol, then degradation of the alcohol into acetic acid, and finally the formation of oxalic acid.

New Elastic Plastic

➤Swim suits, purses, gloves, shoes, raincoats and umbrellas, as well as transparent garden hose and multicolored wire insulation, will be available within a year, made of a new elastic plastic of the Glenn L. Martin Company at Baltimore. The company announced that a new plant to be erected at a cost of $1,500,000 will be in production this fall. It will manufacture only the raw materials.

The new plastic, which will bear the trade name Marvinol resin, is a type of polyvinyl resin compounded of various plasticizers and other ingredients, and will vary from a rigid to a soft "rubbery" state.

Chemical Magic

In A Golden Shower

by Joseph H. Kraus

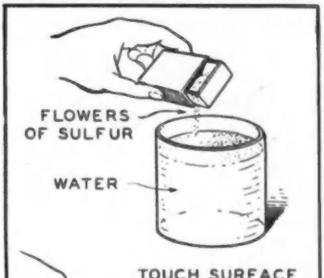
➤ A trick by which you can make a dusty powder floating calmly on the surface of a glass bowl of water suddenly cascade to the bottom in a bright golden stream is one with which you can puzzle as well as please your friends.

This stunt is possible because the surface tension of the water acts like an elastic membrane stretched over its top.

Due to the surface tension, a powder like flowers of sulfur dusted dry on top of the water will not sink. But it can be made to sink by lowering the surface tension of the water by means of a so-called wetting agent. A tiny bit of the wetting agent—so little that it may not be noticed by your audience—is enough to start the sulfur dropping through the surface at the point where the wetting agent is applied.

You can probably buy the flowers of sulfur at your corner drug store. For the wetting agent, it is best to use aerosol. But, in case you have trouble in finding any, you can try various types of washing powders or household cleaning fluids. Many of these contain a wetting agent because this serves to make a better contact between the cleaner and the fabric or article to be cleaned. In washing powders, it helps to make better suds.

To stage your trick, just sprinkle a thin layer of the flowers of sulfur



on top of the water, which should be in a large transparent glass bowl like a fishbowl.

You can ask your friends if they think they can make the sulfur sink by merely touching the surface of the water with their finger tip. When they try to do so, the sulfur remains afloat. But the moment you touch the surface of the water, a large quantity of the sulfur streams through the water to the bottom. The secret lies in the fact that you have first put a small amount of wetting agent on your finger tip.

In order that the wetting agent will not be noticed on your finger tips, dissolve some of the chemical in a little water until it has a paste-like

consistency. When you dip your finger into the paste, enough will cling to the tip to make the sulfur wetter and cause it to sink.

In preparing your experiment, you will want to find out just how little wetting agent is needed to make the experiment work. Pick up a little on the end of a toothpick. Using a clean dish with clean water, sprinkle a new supply of sulfur on top. Now touch the toothpick to the sulfur and watch the sulfur drop to the bottom.

Repeat the experiment, this time being sure there is no greasy film on the water. After filling the glass with water, float on the surface a piece of newspaper large enough to cover it completely. Lift off the paper by picking it up at one end. If any grease was floating on the surface, it will be removed by the paper. Now sprinkle a thin layer of flowers of sulfur on top.

Drop on the water several lumps of wetting agent about the size of large grains of sugar. Watch the surface of the water closely to see how the wetting agent darts about on the water. Just as the membrane of a drum tends to pull away when pierced with a pin, so the surface of the water with the sulfur on it pulls away from the bits of wetting agent.

Answer to All-Chemical Cross Word Puzzle

➤ Don't look now, if you have not done it, but turn to page 37.

P		T		S		C	U	P	R	O		T	R	I
A	M	M	O	N	I	A		H			A	L		S
	E		I			R		E			M		M	O
C	S		C	A	R	B	O	N	I	M	I	D	E	
B	I			L		O		O			N		R	A
	T	O	L	U		X	Y	L	E	N	E		C	C
	Y			M		Y		P		E			A	
G	L	Y		S	U	L	P	H	U	R		S	P	A
	E				N			T		O			T	
	N	I	T	R	I	C		H		L	U	N	A	R
F	E			H			T	A	R				N	A
I				O		I		L		A				T
R		H	Y	D	R	O	B	E	N	Z	O	I	N	S
E	G	G		I		N		I		O		T		
	A		I	C	E		I	N	E		W	E	T	

Industrial Scale Precautions Offer Useful Laboratory Warnings

Danger in the Lab

by Barbara M. Hall

➤ "Caution! Phosphorus is extremely inflammable. Store under water!"

Twelve would-be chemists in an upstate New York high school laboratory grasped their battered lab manuals and crowded around the desk in a desperate attempt to rush through the day's required experiment before the big four o'clock baseball game. A bottle of white phosphorus sticks, a few ring stands and wire gauzes had been placed on the large wooden table, battle-scarred from years of attempted chemistry, biology, and general science experiments.

Ignoring the warning in the lab manual and impatient for the teacher's arrival, the class leader for the day pulled out a large chunk of phosphorus and hacked off pieces for his classmates. The same white phosphorus that drove Japs screaming from their pillboxes and disabled scores of soldiers through hand grenades and mortar missles soon reached its kindling temperature in the warm room and spattered its flaming bits in every direction. Through the dense fumes of the oxide of phosphorus came the screams of the boy whose fingers were burned to the bone, of the girl whose hair had caught fire, and of the others whose skin held bits of searing phosphorus.

The students burned by phosphorus learned too late that warnings in laboratory manuals are not misprints, and their teacher learned too late the necessity for safety lectures, laboratory posters, and first aid training. A few seconds of briefing before the day's experiment on phosphorus would have prevented several months of needless pain.

Burns caused by phosphorus are slow to heal because the cellular elements of the tissues with which the phosphorus comes in contact are destroyed, followed by the formation of ulcers and sores. One first aid book warns that "it is important to keep the affected part under water to reduce oxidation. A 2 to 10% solution of copper sulfate may be used prior to removing the solid bits of phosphorus with a forceps. After the extraction of the phosphorus, the burn may be treated with picric or tannic acid."

New students of chemistry in high schools and colleges may well spend the first week of school in learning to recognize and handle the reagents they will use throughout the year. Even though the quantities they use are small enough to keep danger at the minimum, precautions required of those who handle those materials on a large scale offer valuable hints for safety in the laboratory.

Sulfuric acid, ammonia, and chlorine, among the first reagents students will meet, require individual precautions that should be drilled into every student.

Sulfuric Acid

▸ SULFURIC ACID, the most widely used of all the acids, causes severe flesh burns when splashed on the body. Injury and blindness may result from burns on the eye.

Oleum (fuming sulfuric acid) contains up to 65% of dissolved sulfur trioxide (SO_3) and the fumes which arise from exposure to air are due to this substance. Sulfur trioxide fumes may cause dry, strangling cough and irritation of the mucous membranes of the eyes, throat, and upper respiratory tract.

The acid holes that characterize the laboratory apparel of most students should be a warning to newcomers that sulfuric, even more than other acids, eats it way through ordinary clothing.

One of the most universally employed chemicals in industry, H_2SO_4 is manufactured, transported, and used in quantities of many thousands of tons daily. Few major accidents to workers have been charged against H_2SO_4 If every chemistry teacher were to enforce the regulations and safe practice urged by the Manufacturing Chemists Association and the national and state safety organizations, the accident rate of school laboratories might well compare with the lowered rate in industries using the acid. The first chemistry lesson is a success if the students learn but one thing: that every wasted second adds to the seriousness of acid burns.

Sulfuric acid is usually shipped in steel drums or glass carboys. The following warning label, reproduced here, designed by the Manufacturing Chemists Association, has been adopted as a standard for pasting on all carboys containing sulfuric acid.

Workers are further protected against acid burns and fumes by safety showers, acid hoods, splash-proof goggles, rubber aprons, sleeves, coats, and boots. For emergency use, respirators, gas masks, and bubbler fountains for first aid treatment of eye injuries are standard factory equipment.

SULFURIC ACID

DANGER! **CAUSES SEVERE BURNS**

Do not get in eyes, on skin, on clothing

• CARBOY HANDLING AND STORAGE •

BEFORE MOVING CARBOY be sure closure is securely fastened.

LOOSEN CLOSURE carefully.

KEEP OUT OF SUN and away from heat.

NEVER USE PRESSURE TO EMPTY.

COMPLETELY DRAIN carboy before returning.

IN CASE OF SPILLAGE, flush with plenty of water.

FIRST AID in case of contact:

Immediately flush eyes or skin with plenty of water for at least 15 minutes.

M.C.A. OF U. S. FORM 11 PRINTED IN U.S.A.

Even though chemistry teachers do not supply students in the laboratory with gas masks and respirators, it is their duty to train all students in the basic first-aid measures for preventing serious injuries from spilled or splashed acid.

Three simple first-aid rules for acid burns are listed in "Sulfuric Acid," one of a series of pamphlets entitled "Controlling Chemical Hazards," published by the U. S. Department of Labor:

(1) Apply treatment immediately following the accident.

(2) The best "first-aid" is water in quantity for from 10 to 15 minutes.

(3) Place the injured under care of a competent physician as soon as possible.

Ammonia

➤ "Exposure to high concentrations of ammonia due to accident or carelessness may burn, blind, strangle, kill." This warning issued by the U. S. Department of Labor in "Ammonia," another pamphlet of the "Controlling Chemical Hazards" series, would impress any high school chemistry student. Yet few laboratory manuals stress the danger in handling anhydrous ammonia (NH_3) or aqua ammonia (NH_4OH).

The ammonia encountered in a school laboratory leaves its impression on students as an unpleasant gas that irritates the skin, eyes, nose, and throat. Workers exposed to high concentrations of ammonia, such as used in refrigeration, air conditioning, and fertilizer industries, suffer a spasm of the throat before breathing stops.

Like sulfuric acid, ammonia is shipped in steel drums and glass carboys. Household ammonia, a more common irritating, burning, and splashing hazard, is shipped in bottles, and requires the same precautions in handling as does industrial ammonia. The warning below, also designed by the Manufacturing Chemists Association,

AQUA AMMONIA

WARNING! **LIQUID CAUSES BURNS • VAPOR EXTREMELY IRRITATING**

Avoid breathing vapor. Avoid contact with eyes—skin—or clothing

DRUM HANDLING AND STORAGE •

KEEP PLUG UP to prevent leakage.

KEEP DRUM OUT OF SUN and away from heat.

NEVER USE PRESSURE TO EMPTY.

KEEP LIGHTS, FIRE AND SPARKS AWAY from drum openings.

DRUM MUST NOT BE WASHED OUT or used for other purposes.

REPLACE PLUG after each withdrawal and return with empty drum.

IN CASE OF SPILLAGE flush with plenty of water.

FIRST AID in case of contact:

Immediately flush eyes or skin with plenty of water for at least 15 minutes.

M. C. A. OF U. S. FORM 17 PRINTED IN U. S. A.

tion, is the standard label for drums containing ammonium hydroxide.

First aid posters in the school laboratory should include these rules for burns from aqua ammonia or expose to ammonia gas, as listed in the Department of Labor pamphlet:

(1) Remove any ammonia-soaked clothing.
(2) Flush body or eyes with water.
(3) For shock, wrap in blanket or extra clothing. Call physician.
(4) For exposure to ammonia gas, remove patient to uncontaminated air. Avoid chilling.
(5) If breathing has stopped, immediately start prone pressure method of artificial respiration, not exceeding 18 movements per minute.

Chlorine

➤ THIS POISONOUS war gas, whether inhaled by enemy soldiers during a war, industrial workers, or teen-age chemistry students, causes coughing, labored breathing, and all the symptoms of a hard cold. If excessive quantities are breathed, great respiratory distress and rapid death may result. The U. S. Department of Labor pamphlet, "Chlorine," summarizes the effects of frequent inhalation of low concentrations of the gas as causing "loss of sense of smell, convulsive coughing, gastritis, loss of appetite and weight, headache, giddiness, insomnia and heart disturbances."

Chlorine gives warning of its presence in the air by a pungent odor and a greenish-yellow color. Since it is heavier than air and tends to settle, the first rule to remember is to keep your head high. Avoid deep breathing and coughing, and try to keep your mouth tightly closed. Carry anyone overcome by the gas into uncontaminated air, preferably to a room where the temperature is around 70° F. Place him on his back with his head and back elevated. Keep him warm and quiet, until the arrival of a physician and try to prevent him from coughing.

A ready-prepared carbon dioxide and oxygen mixture, included in the chlorine exposure emergency apparatus for industries using the gas, is administered to unconscious patients every two minutes for not more than one-half an hour. As a protection against injury, employees who might be exposed to chlorine in such industries as textile, water sterilization, and sanitation, are issued chlorine gas masks of a design approved by the U. S. Bureau of Mines.

Splashes of liquid chlorine and chlorinated water destroy clothing, and cause skin burns that should be treated with as much caution as is used for any other acid burn.

Certain quantities of war-essential nitro-cellulose were obtained by Germany from a neutral country that was importing huge quantities of a manicuring preparation containing this material from the Allies.

Distiller Tries to Show Farmer How to Make Alcohol for Fuel

Alcohol From Farm Wastes

➤ A NEW STEP toward the solution of an old problem appeared at the Chemical Exhibition held in Chicago concurrently with the meeting of the American Chemical Society. The problem, stated in its simplest terms, is how to make industrial alcohol from farm wastes. It has a long history, and implications which run disturbingly into many different fields. The latest development is sponsored by Joseph E. Seagram & Sons, the distillers, who claim to know something of the problems of alcohol production.

The reason for industrial alcohol is that, no matter whether the public is alarmed by forecasts of oil shortages or lulled by reports of new oilfields brought into production, when we burn petroleum we are using by the minute stuff that took millenia to form. We are squandering our heritage instead of living on our income. This worries the chemist, who realizes that alcohol, whose properties as a fuel are quite comparable to those of gasoline, could be made easily and cheaply from farm wastes. So much for the general statement of the problem.

Any proposal concerning alcohol runs immediately into a maze of conflicting special interests. Basic to the emotional confusion on the subject is the effect alcohol has on the human nervous system. The vagaries of behavior which result from drinking alcoholic beverages have called forth a variety of laws and resulted in a complex structure of regulations and taxation. Taxation ties the problem in with national income. Looked at from the economic level, the question of whether the farmer can burn alcohol becomes very complex indeed.

In the interval between the two world wars, a group of chemical industrialists, headed by Dr. Wm. J. Hale, launched a program under the name of "Chemurgy" to promote the manufacture of alcohol from farm wastes, including the then surplus crops. Their solution to the fuel problem was to legalize the mixing of alcohol and gasoline. Shifting of the world economic pattern as a result of the war has changed the method of approach to the problem.

It is still not only possible but practical to get alcohol by fermenting almost any kind of carbohydrate material and distilling the resulting liquid. According to the Seagram chemists, what the farmer chiefly needs is a well-designed small chemical plant and a carburetor planned exclusively for 95% alcohol. The pioneer farm-scale alcohol plant was exhibited as a working model in Chicago. It was in complete operation, even to a special license, for the six days of the exhibit, and two U. S. Treasury inspectors, whose presence the government requires to insure no diversion into illegal channels wherever alcohol is distilled.

The plant is described by its spon-

➤ Complete alcohol plant *for the farm, as exhibited at the Chemical Exposition at Chicago. It is designed to turn three bushels of the farmer's waste carbohydrate material per day into fuel alcohol. The framed document on the side of the glass-enclosed unit is the special license issued by the U. S. Treasury Department for the duration of the exhibit.*

sors as a continuous process unit for the production of agricultural alcohol, a compact, shiny assembly of mill, cooker, fermenter, and distillery, which will manufacture 7½ gallons of 95% ethyl alcohol per day from three bushels of corn (or potatoes or fruit or any other carbohydrate crop). The Seagram research scientists have put together this smoothly working maze of pumps, hydrolizers, steam jets, cooling pipes, controls—a great plant in miniature—in a unit only a little bigger than a kitchen stove.

The production of agricultural alcohol from surplus, sub-standard, and waste, as well as prime crops, for use on the farms of America and especially of those countries with little or no natural fuel, is part of a far-sighted program of industrial-agricultural co-operation. One of the major problems of our intensely mechanized economy is that of fuel. All nations, even those with temporarily adequate natural reserves, are troubled about the future, and there is today ominous bickering

over the few remaining undeveloped oil deposits.

An agricultural alcohol program, while it cannot at this time even begin to answer the world's vast need for fuel, is of great significance to the farmer. Since the tractor replaced the horse on farms everywhere, the farmer has had to pay cash for his fuel, as well as for the manure which used to be supplied by the horses. Many acres of forage crops were also taken out of production at that time. By a return to the land for power, the forage crops would once more be useful as a source of fuel. Moreover—and this is a point of much interest to soil conservationists—alcohol is made only from the carbohydrate portions of crops, leaving the minerals to be returned to the soil. In short, agricultural alcohol will add to the fertility of the land rather than deplete it, at the same time decreasing the drain on natural resources.

The development of the continuous process unit for the manufacture of agricultural alcohol was inspired by the belief of Mr. H. F. Willkie (Seagram's vice president in charge of production) that among nations differing sharply in economic, political, and moral philosophy, the two great bases of international understanding are science and agriculture. "I propose that we develop a new world," says Mr. Willkie, "in which we incorporate ideas, methods, and institutions, based not upon political expediency, but rather upon a sounder economic validity. Only then will the political freedom have a strong fertile soil in which to grow."

Western Waste Lands

➤ The reclamation of millions of waste acres, particularly in 17 arid or semi-arid western states, offers the opportunity to provide much-needed, fertile fields for the production of food required to keep pace with growing world needs Kenneth W. Markwell of the U. S. Bureau of Reclamation declares.

There is great need for rebuilding the soil, bringing under cultivation new acres that can be farmed economically, harnessing rivers for power, flood control and navigation, and in addition "utilizing to best advantage every drop of water in the West."

In contending that reclamation of the West is essential for a better-fed and healthier America, Mr. Markwell asserted that conservative estimates based upon studies made by the U. S. Department of Agriculture forecast the necessity for bringing about 40,000,000 new acres of land under cultivation by 1960 to replace marginal and sub-marginal land to meet the needs of a growing population and to supply normal export markets.

White-skinned peanuts, developed by selection at the Georgia Experiment Station, may be ground and used for making peanut butter without the removal of the skin and hearts which contain more vitamin B than the meat of the peanut.

Evaporate

▸ In the laboratory *it is often necessary to evaporate the solvent to recover the dissolved salt or other solid in crystalline form, as shown in this photograph by Fremont Davis, Science Service staff photographer. On the industrial scale, evaporating dishes become huge tanks, like those shown below.*

▸ Magnesia *is recovered from sea water in these tanks installed at the Dow Chemical Company's plant at Freeport, Texas. The tanks are known as Thickeners, built by the Dorr Company, whose research and testing laboratories are at Westport, Conn. They report that they can build such thickeners up to 375 ft. in diameter.*

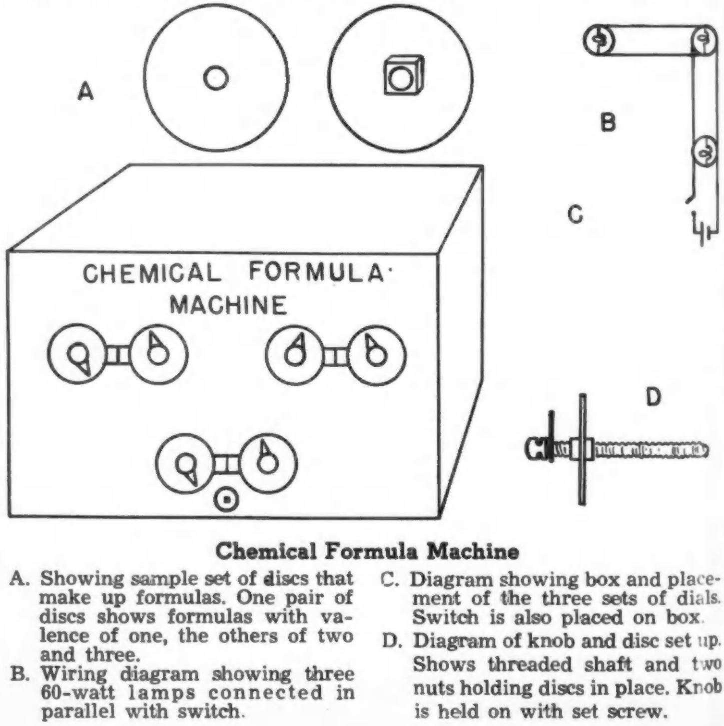
Science Club Projects
Your Classes Can Do

Formulas at Your Fingertips

➤ Any one of 512 different chemical formulas in a few seconds! A Chemical Formula Machine is only one among the many interesting projects that members affiliated with Science Clubs of America can make.

Teachers often ask, "What would I tell my students to do if I started a science club in my school?" The students themselves answer this question in the pamphlet "1,000 Projects For Science Clubs," originated by members of Science Clubs of America and distributed without charge through National SCA Headquarters, Washington, D. C., to affiliated clubs.

All projects are those which members themselves have chosen to do on



Chemical Formula Machine

A. Showing sample set of discs that make up formulas. One pair of discs shows formulas with valence of one, the others of two and three.

B. Wiring diagram showing three 60-watt lamps connected in parallel with switch.

C. Diagram showing box and placement of the three sets of dials. Switch is also placed on box.

D. Diagram of knob and disc set up. Shows threaded shaft and two nuts holding discs in place. Knob is held on with set screw.

their own initiative and not what adults think science clubs should do.

Chemistry clubs may prepare interesting exhibits that will provide lots of fun along with worthwhile and meaningful experiences which have instructional value in the science classroom. Such exhibits may then be entered in school science fairs, open house programs, and other interesting and educational displays. They are very helpful in making for an overall school interest in the science department.

Younger members are usually interested in a variety of science fields. Therefore, a General Science Club in which they study any or all fields of science is appropriate.

Members past the age of 14 or 15 have usually settled on a few fields of specific interest. They want to have a Chemistry, Microscopy, Radio, or Photography Club etc., etc.

Your club can do such things as: learn the science in your city, plan excursions, arrange talks and demonstrations, review science books, study science biographies, encourage individual research projects, etc. Club members can participate in a science congress, science fair, photographic salon and other interesting activities.

Science Clubs of America supplies these free manuals to affiliated clubs:

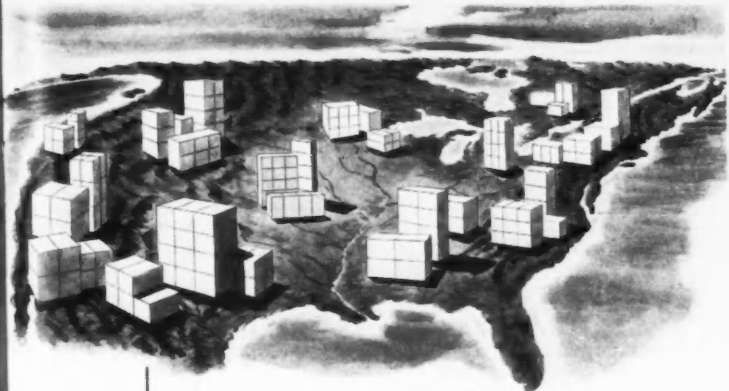
How to Organize and Activite Your Science Club

1000 Projects for Science Clubs

Free and Low-Cost Materials for Science Clubs

Books for Science Clubs

➤ SNAPSHOT *of the Chemical Formula Machine made by the Newtown, L. I. Science Club, as exhibited at the World's Fair.*



SCA Co-Projects
SCA Sponsor Guide
and other useful materials and news of activities of science groups.

Write today to Science Clubs of America, 1719 N Street NW, Washington 6, D.C. to get this free help for your club members.

Chemical Formula Machine

➤ A FEW YEARS AGO, a chemistry club at Newtown High School, Long Island, New York, constructed a Chemical Formula Machine with which they could portray 512 different chemical formulas. The exhibit proved to be so popular that it was placed on exhibition at the New York World's Fair and rceived constant attention from the throngs of visitors that crowded around it daily. It was a true tribute to the accomplishments of the youthful club members who constructed it.

By merely turning two of six dials of the Chemical Formula Machine, a formula is at your fingertips. The machine provides a "teaching tool" to the chemistry department and an interesting and easy visual method of learning chemical formulas.

Construction of the Chemical Formula Machine is very simple. The sides of the machine are made from plywood or pressboard about 24 x 30 x 12 inches (see illustration C). The six revolving discs are made eight inches in diameter from any 1/16th inch transluscent material and the formulas are to be painted on with black paint. Printed names which correspond to the names of the formulas on the discs are painted on the outside front panel of the box.

A person desiring to find the formula for potassium chloride turns the left hand dial to potassium. The letter K (the symbol for potassium) appears in the cut-out hole. He then turns the dial to chloride and the letters Cl appear on the opposite cut-out. All adjacent discs have corresponding valences. You then have the formula KCl for potassium chloride. The other four dials work in the same manner. The three sixty watt light bulbs within the box are used merely to illuminate the discs so they can be read easily (see illustration B).

The total cost of construction of this machine runs from one to three dollars and is a project that will provide the club members who build it with a piece of equipment they not only can use but can contribute to class- or club-room equipment.

Radicals for Valence I Discs

Left hand Disc:		*Right hand Disc:*			
Element	*Formula*	*Radical*	*Formula*	Oxide	$_2O$
Hydrogen	H	Fluoride	F	Sulphide	$_2S$
Lithium	Li	Nitrate	NO_3	Sulphate	$_2SO_4$
Sodium	Na	Acetate	$C_2H_3O_2$	Carbonate	$_2CO_3$
Potassium	K	Bicarbonate	HCO_3	Phosphate	$_3PO_4$
etc.		Chlorate	ClO_3	Hydroxide	OH
				Chloride	Cl
				etc.